# AN EXAMINATION OF THE DETERMINANTS OF RESIDENTIAL ELECTRICITY SALES WITH SPECIAL EMPHASIS ON THE EFFECTS OF ADVERTISING

By

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A Dissertation Presented to the Graduate
Council Of The University of Florida In Partial
Fulfillment of the Requirements For The Degree Of
Doctor of Philosophy

University of Florida
1973

# ACKNOWLEDGMENTS

To the members of my committee, Professors Carter C. Osterbind, Ralph B. Thompson, Ralph H. Blodgett, Robert W. Bradbury, and John M. Champion, I wish to express my sincere appreciation for their interested efforts on my behalf. I must express my special indebtedness to the chairman of my committee, Professor Osterbind, who has been unsparing of his time and energy and who has been hard upon the weaknesses of this dissertation.

Appreciation is also expressed to the following: Professor John Trapani, Assistant Professor of Economics at the University of Texas at Arlington, for his helpful comments on the statistical analysis employed in this dissertation; Mr. Ted Heithaker of the University of Texas at Arlington Computer Center staff for his valuable programming assistance; and to Professor J. D. Butterworth for his many contributions to my personal and intellectual development.

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# AN EXAMINATION OF THE DETERMINANTS OF RESIDENTIAL ELECTRICITY SALES WITH SPECIAL EMPHASIS ON THE EFFECTS OF ELECTRIC UTILITY ADVERTISING

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August, 1973

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The rapid historical and projected increases in the residential demand for electricity have become a source of growing concern for various conservation and environmental groups. Their concern stems from the fact that electricity production entails the consumption of increasing quantities of the nation's diminishing fossil fuel reserves, and from the fact that electric power production creates considerable air, water, and thermal pollution. The concerns of these groups have been translated into active lobbying in favor of measures designed to stem the rapid increases in the residential demand for electricity. Electric utility advertising has been a favorite target of these lobbying activities. These groups question the efficacy of advertising to stimulate the demand for a product whose production entails environmental pollution and the consumption of natural resources which are irreplaceable and in short supply. In addition, there are those consumer groups that find electric utility advertising unacceptable

because in their view it only adds to the cost of electricity. In other words these groups at least implicitly reject industry arguments that advertising through its demand stimulation role brings cost reductions by helping to improve plant utilization or by permitting utilities to take advantage of scale economies.

The above discussion suggests something of the importance of the problem. The fact that regulatory commissions have taken actions, including prohibition of electric utility advertising, designed to dampen the residential demand for electricity coupled with the fact that there have been no empirical studies of the determinants of electricity demand establish the need for the study.

Two hypotheses are examined in the study. First, it was suggested that electric utility advertising has been a relatively insignificant factor in the growth of residential electricity sales, and that these sales have grown in response to forces which are largely outside the control of electric utility firms. These forces include: the residential stock of electrical appliances, weather conditions, consumer income, the marketing and product innovation activities of appliance manufacturers, and electricity price. Time-series data for the industry and cross-sectional data for a sample of electric utility firms were analyzed by means of multiple regression to test this hypothesis. The results of this analysis generally support the validity of the hypothesis.

Second, it was suggested that advertising by electric utilities may serve other functions besides sales stimulation, and that some of these other functions may justify its use. Any prohibition of electric utility advertising which fails to recognize these other functions

should be considered as hasty. This hypothesis was evaluated on largely hypothetical grounds. It was concluded that electric utility advertising may serve functions other than sales stimulation, and that its use as a vehicle to inform and educate electricity consumers is perhaps the most important of these other functions.

Several general conclusions and recommendations emerge from the study. First, it appears that a total prohibition of all electric utility advertising is not likely to have a significant effect on the residential demand for electricity or on the cost of electricity to residential consumers. Second, there is evidence to suggest that prohibition of electric utility advertising might deprive consumers of certain benefits such as useful information. Third, it would seem that prohibition of advertising by electric utilities without a similar prohibition of advertising by electrical appliance manufacturers would be almost totally ineffective. Finally, it would seem that it would be desirable for regulatory commissions to encourage electric utilities to devote more of their advertising effort toward informing and educating consumers in safe and efficient electricity consumption.

# CHAPTER I

# ELECTRIC UTILITY ADVERTISING AND RESIDENTIAL ELECTRICITY SALES: INTRODUCTION

## Origin and Purpose of the Study

Privately owned electric utilities spent over $70 million on advertising and over $230 million on other types of promotion in 1969 [222, p. XXXVI].*[1] Advertising by privately owned electric utilities increased by more than 330 percent over the 1950-1969 period [222, p. XXXIII]. Over this same period unit sales by privately owned electric utilities to residential customers increased by 494 percent, while dollar sales to residential customers increased by 355 percent -- from $1.5 billion to nearly $7 billion [222, pp. XXXIII].

### Concern Over Sales Gains

The rapid growth in the residential demand for electricity has become a source of increasing concern in recent years [103, 149, 158,

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*The number in the preceeding brackets indicates the number of the reference for the above material. The list of references is provided in the last section of this dissertation. This system is employed throughout the dissertation. More than one reference may be cited within a set of brackets. Page numbers are also cited within the brackets if the reference is to a specific passage in the cited work.

[1] Advertising is defined as "...any paid form of nonpersonal presentation and promotion of ideas, goods, or services by an identified sponsor" [8, p. 9]. For a list of the specific items that electric utilities include in their advertising budgets see Appendix F. Also see Appendix F for a discussion of the other types of promotion employed by electric utilities.

159, 172, 175, 177, 182, 201, 218, 224].[1] This concern stems from several sources. First, there is concern over the natural resource consumption associated with the production of increasing quantities of electric power [175, 201, 224]. Second, there is concern over the various types of pollution created as byproducts of the electric power production process [175, 201, 224]. Next, there is concern over the relative shortages of electric power which have developed in certain parts of the country [175, 201].[2] There has been a tendency for those groups concerned with the above problems to place at least some blame for the rapid increases in the residential demand for electricity on advertising by electric utilities [103, 175, 201]. Their arguments against utility advertising assume, at least implicitly, that such advertising has a significant positive effect on the residential demand for electricity.

In addition to those who oppose utility advertising on ecological, power shortage, and conservation grounds, there are those who oppose electric utility advertising on economic grounds [103, 149]. But, while the former group of critics oppose electric utility advertising because of its supposed positive effects on the demand for electricity, those opposing utility advertising on economic grounds argue that such advertising has no effect on the demand for electricity and, therefore, only adds to the costs of electricity which must be born by consumers [103, 149, 172].[1] These critics, often organized in consumer groups, criticize not only utility advertising aimed at demand stimulation but also institutional or image enhancing advertising by utilities [103]. These critics find it particularly noxious that a regulated monopoly firm which consumers must patronize is in a position to force consumers to pay for advertising whose objective is to make these same consumers think well of this monopoly firm [149].

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[1] The term demand is used frequently in this dissertation. Unless otherwise specified, the term is used to refer to market demand. Market demand is defined as "...the actual quantity of an economic good which buyers take off the market in a given period at a certain price" [30, p. 251].

[2] See Appendix A for a more detailed discussion of the ecological conservation, and power shortage problems facing the industry.

In summary, the foregoing discussion indicates that there has been considerable criticism of utility advertising. It was noted that though all these critics argue that utility advertising should be completely eliminated, or at least drastically reduced, they tend to disagree in their reasons for this public policy recommendation. Those critics concerned with conservation, ecology, or power shortages, tend to support the thesis that electric utility advertising has been an important factor in electricity sales growth, while those critics who contend that utility advertising adds only to the cost of electric

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[1] The costs must be borne by consumers because of the way in which privately owned electric utilities are regulated. Privately owned utilities are typically permitted to earn some fair rate of return on their rate base [14]. The calculations required to compute this rate of return are summarized in the formula below [124]:

$$r = \frac{R - O}{V - D}$$

where: R = total revenues
O = operating costs
V = value of utility's assets
D = accumulated depreciation

The permissible rate of return (r) is set by the regulatory commission [14]. Since all operating expenses are deducted in arriving at the permissible rate of return, the privately owned utility enjoys what amounts to cost-plus pricing. The above logic is sometimes countered power suggest that advertising has no effect on the demand for electric power.

## The Industry Position

The privately owned electric utility industry has typically defended the intensity of its advertising and promotional activities by arguing that these activities enable individual electric utility firms to achieve production cost savings which more than outweigh the costs of the advertising necessary to achieve them [242]. It is argued that the net savings, so achieved, are passed on to electricity consumers in the form of lower rates [71, 162].

It is argued that the potential production cost savings which result from advertising by electric utility firms come from two sources. First, if utility firms are able to increase the general level of demand for electricity through advertising, they can increase the scale of their operations, and thereby reduce unit production costs [162, 163, 243]. Second, individual utility firms may be able to improve the utilization of their plants through advertising [162, 243, 244]. Improved utilization requires that electricity consumers be persuaded (or educated) to use more electricity during periods of the day or year when the demand for electricity is low [242]. For example, an advertising campaign designed to get more people to use electric blankets

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with the argument that the utilities are not guaranteed that they will make the maximum allowable rate of return [157]. However, a search of rate of return statistics for the past ten years failed to locate one example of a privately owned electric utility earning less than the allowable rate of return [222]. In contrast to the regulated utilities, nonregulated firms advertise at their own risk. They advertise with the hope that advertising will increase revenues more than it will increase costs. This question is considered in greater detail in Chapter II.

would, if successful, improve plant utilization because the hours during which people sleep are hours of low electricity demand [85]. Any improvement in plant utilization, which averaged less than 50 percent across the industry in 1969, will necessarily reduce unit production costs as the fixed costs associated with physical plant are spread over a larger number of units [26].

It was noted above that there are two ways in which advertising might conceivably bring reductions in the unit cost of producing electricity. Both of these avenues to production cost reduction through advertising require that advertising be able to affect the behavior of individual residential consumers. General demand stimulation, and the resulting scale economies, requires that advertising be able to persuade a significant number of consumers to use more electricity than they used previously [243]. Improved plant utilization through advertising requires that advertising be able to persuade or educate consumers to change their electricity usage patterns [162].

Although no hard evidence could be found in the literature to support the contention that advertising affects consumer behavior in the above ways, the courts and regulatory commissions have tended to support the idea that electric utilities are able to lower their costs through the vehicle of advertising [157, 175, 201]. In deciding on the appropriateness of a particular utility's advertising expenditures, the courts and regulatory commissions have not required that the utility prove the efficacy of the proposed expenditures, but have rather looked to what that particular utility spent in the past and to what other comparable utilities spend on advertising [157].

The above discussion suggests that electric utilities find themselves in an unenviable position in regard to their advertising activities. If the industry were able to demonstrate that its advertising stimulates the residential demand for electricity and therefore opens up possibilities for consumer price reductions, those critics who claim that electric utility advertising increases the price of electricity to consumers might be placated. However, those who criticize electric utility advertising on environmental, conservation, and power shortage grounds would be further inflamed. On the other hand, evidence which showed that advertising by electric utilities has no effect on the residential demand for electricity would placate those concerned with the rapid increases in electricity consumption, while confirming the arguments of those who contend that electric utility advertising only adds to the cost of electricity. As a result of this conflict, industry spokesmen have occassionally found themselves in the curious position of suggesting before one particular group that electric utility advertising has little effect on the residential demand for electricity; while suggesting to another group that such advertising has a significant effect on the residential demand for electricity [71, 175].

It should be noted that there have been some attempts to employ advertising as a vehicle to educate residential consumers in the efficient use of electricity [175, 201]. There is some feeling that advertising of the above type might be used to curb the rapid growth in the residential demand for electricity [175, 201].[1] However, it should be remembered that the ability of advertising to dampen demand depends, as does its ability to stimulate demand, on its ability to affect the behavior of individual consumers [153]. It would, therefore, seem reasonable to suggest that if electric utility advertising cannot stimulate the demand for electricity that it is also unlikely that advertising can significantly dampen the demand for electricity. In other words, if advertising cannot affect the behavior of consumers so that they use more electricity it is unlikely that it can affect their behavior so that they use less electricity or that they use it more wisely. Of course, this line of reasoning can be turned around. If it can be shown that advertising does stimulate the demand for electricity it would therefore seem likely that advertising can dampen the demand for electricity.

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[1] In 1972, Consolidated Edison spent $500 thousand on a consumer education advertising campaign [201].

## Research Purposes and Working Hypotheses

The above considerations prompted the author's interest in the effects of electric utility advertising on the costs of electricity and upon the residential demand for electricity. It seems that if advertising is to have any beneficial impact on the costs of electricity to residential consumers, it is first necessary that it have some positive effect on electricity sales. The major purpose of this research is, therefore, to examine the relationship between advertising by electric utilities and their residential sales of electricity. This question is an interdisciplinary one and, therefore, requires an interdisciplinary approach. Though the question of advertising falls largely within the domain of marketing, thorough examination of this problem requires a consideration of costs and demand, topics which fall primarily in the province of economics. This topic also requires a consideration of the regulatory process which falls primarily within the provinces of economics and law.

The secondary purpose of the research is to examine considerations, other than those concerned primarily with costs and sales, which might justify or condemn the use of advertising by privately owned electric utilities.

In connection with the primary purpose of this dissertation (advertising-sales relationship), preliminary analysis leads to the hypothesis that advertising by electric utilities has been an insignificant factor in the growth of the residential demand for electricity. It is further hypothesized that this growth in residential demand can be largely attributed to factors outside the control of individual utility firms. Foremost among these factors is the stock of electrical appliances in the hands of residential consumers. It is suggested that growth in the residential demand for electricity is closely and positively related to the growth in residential appliance stocks.[1]

In addition to the growth in appliance stocks, it is felt that growth in consumer income has been a major factor in the increased residential demand for electricity. A positive relationship between consumer income and the residential demand for electricity is expected.

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[1] It is suggested that appliance stocks are often more influenced by aggressive marketing, including product innovation, on the part of appliance manufacturers and retailers than they are influenced by the marketing activities of electric utility firms. Not only is the marketing effort of the privately owned electric utility industry much smaller in magnitude than that of the electrical appliance industry, but advertising of electric utilities also seldom emphasizes particular electrical appliances [35].

Weather is a third factor, outside the control of electric utilities, hypothesized to be an important determinant of the residential demand for electricity. The increased use of electric home air conditioning units and electric home heating units have made weather conditions a factor of increasing importance in determining the residential demand for electricity.[1] It is expected that relative residential consumption of electricity is higher in warmer regions.[2] The competitive environment is a final factor, outside the control of electric utility firms, which is expected to have a significant influence on the residential demand for electric power. Specifically, competitive conditions are defined to include the price and promotional activities of natural gas utilities. One would expect the residential demand for electricity to decline as the price of gas declined relative to the price of electricity or as the promotional activities of gas utilities were increased relative to the promotional activities of electric utilities.

In addition to the four factors mentioned above, which are outside the control of electric utility firms, it seems reasonable to suggest that the price of electricity, which is largely under the control of individual utility firms, is a significant determinant of the residential demand for electricity.[3] An inverse relationship is expected between the price of electricity and the residential demand for electricity. It is also expected that the nonadvertising promotional activities of electric utilities may be significant determinants of the residential demand for electricity.[1]

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[1] The term weather is used in this dissertation to refer to the temperature (hot and cold) conditions which prevail in a particular geographic area. This variable could not be used in the time-series analysis of industry data because it is impossible to characterize weather conditions for the entire United States for a given year.

[2] Rationale for this hypothesis is provided in Chapter III.

[3] Privately owned electric utilities are not free agents in regard to the prices they charge for electricity [42]. Rates charged for service and changes in these rates must be approved by regulatory commissions [162, 144].

In summary, it is suggested that residential electricity sales are a function of a number of factors, including: 1) the residential stock of electrical appliances; 2) weather conditions; 3) consumer income; 4) competitive factors, including the price and promotional activities of natural gas utilities; 5) the price of electricity to residential consumers, and; 6) the promotional activities of electric utilities. It is expected that residential electricity sales are positively related to appliance stocks, warmth of climate, consumer income, the price of natural gas, and the promotional activities of electric utility firms and inversely related to the price of electricity and to the promotional activities of natural gas companies.[2]

In regard to the secondary purpose of this dissertation, it is hypothesized that there are considerations other than those connected with the sales and cost effects of advertising which may justify the use of advertising by electric utilities. It is suggested that the emphasis on the sales and costs effects of electric utility advertising has tended to obscure other benefits of advertising which may accrue to those who produce and to those who consume electricity. Other

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[1] Data problems precluded any serious examination of this hypothesis. These data problems are discussed in detail later in this chapter.

[2] A detailed justification for these hypotheses is provided in Chapter III.

possible justifications for electric utility advertising include the following: 1) advertising is a form of free speech and restriction of advertising is restriction of free speech; 2) advertising by electric utilities provides needed market information, information of an educational nature, to residential consumers of electricity; 3) advertising by electric utilities augments the need satisfying ability of their service; 4) electric utilities do not enjoy monopoly status in all of the market segments they serve and advertising is therefore necessary as a competitive tool.

It is suggested that arguments two, three, and four above have some validity, while argument one is largely a smoke screen.[1]

## Interest in Research Findings

It would seem that the findings of this research effort would be of potential interest to a number of different people. First, it seems that the findings of this study might be interesting, and perhaps useful, to those concerned with the regulation of privately owned electric utilities. State regulatory commissions, for example, are charged with the responsibility of evaluating and determining the appropriateness of the advertising expenditures of the privately owned electric utilities which fall under their jurisdiction [42, 44, 115]. As noted earlier, these state regulatory commissions have no direct evidence as to the sales impact of electric utility advertising. The findings of this research should provide these commissions with a better idea of the efficacy of electric utility advertising expenditures than they presently have.

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[1] These arguments are discussed in Chapter II.

Second, the Federal Power Commission, though not directly involved in the detailed regulation of individual electric utility firms, is concerned with the development of broad national goals, priorities, and policies in regard to the development and efficient utilization of the nation's power resources [218, 225]. It seems reasonable to suggest that the findings of this dissertation would be useful to the Federal Power Commission in the development of guidelines for electric utility advertising activities.

Third, the findings of this research may be useful to the courts of law which must resolve disputes between privately owned electric utility firms and regulatory bodies, or between utility firms and various consumer, ecology, and conservation groups. These findings would, of course, be of particular interest in those cases involving disputes over the appropriateness of utility advertising expenditure levels or advertising content.

Fourth, the findings of this research effort should be of interest to privately owned electric utility firms. Useful in helping these firms reevaluate the types and quantities of advertising they should be supporting at this time when their marketing activities have come under so much criticism.

Fifth, the findings of this research should be of interest to consumer groups, conservation groups, and people concerned with the electric power shortage. This examination of the relationship between electric utility advertising and residential electricity sales should provide some evidence as to whether advertising has been a major factor in the growth of residential electricity sales and, thus, whether advertising by electric utilities is a factor to which these various groups should be devoting their attention.

Finally, it should be noted that, though this study is concerned primarily with the relationship between electric utility advertising and residential sales, the impact of other hypothesized determinants of the residential demand for electricity will be evaluated. Determining which of these factors have been significant in the growth of the residential demand for electricity considerably broadens the scope of the study and leaves open the possibility for public policy recommendations outside the area of electric utility advertising.

## Literature in the Field

### Literature Search

There is an abundance of published information about the electric utility industry. There is considerably less published material on the question of electric utility advertising. There are no published empirical studies -- or at least none could be found -- which examine the relationship between electric utility advertising and the residential demand for electricity. The literature search included the following items: 1) all major academic and practitioner journals that deal with marketing, economics, public utility, and regulated industry topics and all major indexes which list periodicals of the above type; 2) publications and reports of various regulatory agencies, particularly those of the Federal Power Commission; 3) United States Congress hearings on the subject of utility promotional practices; 4) selected books on the topics of marketing, advertising, electric utilities, and public utility economics.

## Possible Reasons for the Lack of Research

Given the large sums of money involved, the possible environmental impact, and the relative shortage of electricity, one wonders why no researcher has seen fit to examine the relationship between electric utility advertising and electric utility sales empirically. Several possible reasons may be suggested for the lack of interest and attention this topic has received. First, the problems, discussed in the previous section, which prompted this study are relatively recent in origin. Power shortages are new to the United States -- a development of the mid and late 1960's. Electric utility firms have been consuming valuable natural resources and polluting the air and water ever since Edison put his Pearl Street generating station in service in New York in 1879 [76, p. 148]. However, widespread concern over this pollution and natural resource consumption is a relatively recent phenomenon. This concern is not a random happening but can be largely attributed to the fact that pollution and natural resource consumption by the electric power industry have reached alarming levels only in recent years [175, 201]. Finally, it should be noted that militancy among consumer groups that feel advertising by electric utilities adds only to the cost of electricity is also of recent origin [149].

A second reason for the lack of research attention to the electric utility advertising-residential sales relationship might be the relatively small size of dollar advertising expenditures in relation to revenues from residential sales.[1] For example, in 1969 expenditures on advertising by electric utilities amounted to 1 percent of revenues from residential sales on the average [222, p. XXXV]. This is certainly not a percentage that calls attention to itself. However, it should be noted that General Motors, Ford Motor, Standard Oil of New Jersey, Standard Oil of Indiana, Shell Oil, Armour, Swift, Texaco, Alcoa, 3M Company, General Electric, American Telephone and Telegraph, American Can, General Telephone and other firms sometimes thought to be big advertisers all spent less than 1 percent of sales revenues on advertising in 1969 [127, p. 276].

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[1] Residential sales revenues are used because nearly all electric utility advertising is directed toward residential customers [94, 110].

Finally, lack of attention to the utility advertising-residential sales relationship might be attributed to the fact that among marketing students the best minds have been either directed toward the development of general theories of buyer behavior or toward the application of mathematical and statistical techniques to marketing phenomena. This trend has been evidenced in the editorial policies and article selection of major marketing journals, most notably the Journal of Marketing Research, and witnessed by Halbert [86], Howard [96], and Shubik [183]. The point is that interest in the development of theories of buyer behavior and the application of mathematical techniques to marketing phenomena have perhaps diverted attention from special marketing problems such as the effectiveness of electric utility advertising.[1]

## Literature on Electric Utility Advertising

It was noted that a number of articles dealing with the general topic of electric utility advertising were found in the literature search. These articles are of two general types. First, there are those articles which deal with the facts of electric utility advertising -- amounts spent, media employed, etc. Second, there are those articles that deal with the hypothetical effects of electric utility advertising -- its impact on utility production costs and profits, consumer satisfaction, costs of electricity service to residential consumers, etc.

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[1] For a comment on general versus special theories see Appendix B.

Two articles dealing with the facts of electric utility advertising, one by William Kelley [110] and one by the Public Utilities Fortnightly staff [94], were found. The Kelley article deals with the question of how much gas and electric utilities actually spend on advertising and other types of promotional activity [110]. Kelley's main purpose is summarized in the following passage [110, p. 394]:

> In answering the question, how much should a gas or electric utility spend on sales promotion in total and by various categories, one must develop yardsticks or standard ratios for the industry. The yardsticks employed in this study are the proportion that sales promotion expense categories bear to total operating revenues and to total operating expenses.

Kelley thus looks to what utilities actually spend on advertising to answer the question of how much they should spend. The efficacy of actual expenditure levels is not questioned. The relationship between advertising and sales is not considered. Basically, the Kelley article consists of a compilation of promotional expenditure data from Federal Power Commission Sources.

The second article in this category, "How Utilities Use Their Advertising Budget," was published in 1964 and deals with the question of how much of the average electric utility's advertising budget is spent on various types of media [94]. This information is useful and is cited later in this chapter. However, this article does not consider the relationship between electric utility advertising and electricity sales.

The second set of articles, those which deal with the hypothetical effects of electric utility advertising, include works by Reif and Knoke [162] and Wotruba [242, 243, 244, 245]. These five articles have a common thread running through them in that they stress the fact that advertising by electric utilities benefits both utility firms and residential consumers of electricity. In all of these articles, it is implicitly assumed that advertising by electric utilities has a significant effect on the residential demand for electricity. This assumption is made without any supporting empirical evidence.

The Reif and Knoke [162] and Wotruba [242, 243, 244, 245] articles suggest that positive benefits from advertising flow to the utility firm in the form of increased profits, lower production costs, and consumer good will; while positive benefits from electric utility advertising flow to residential customers in the form of lower electricity costs and greater satisfaction from the use of electricity services.[1]

## Congressional Hearings on Utility Promotional Practices

In response to the widespread concern over utility promotional practices, Congress held hearings on the subject in 1968 [208].[2] These hearings, though producing over 1200 pages of officially recorded testimony, provided no substantial evidence of the sales or cost impact of electric utility promotion [209]. The House committee did not make any policy recommendations based on their investigation. The committee did, however, request that the Federal Power Commission and the National Association of Regulatory Commissioners gather information about the promotional activities of electric utilities in the various states [209]. These two groups cooperated in the preparation of a detailed report on electric utility promotional practices [221]. However, their study is entirely descriptive, it includes no public policy recommendations in regard to utility promotional practices.

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[1] These points are discussed in greater detail in the extended literature search of Chapter II.

[2] It should be noted that fuel oil dealers, feeling that electric utilities were employing unfair methods of competition against them, were a major force in pressing for these hearings [208].

### Literature on Electric Utility Economics

The literature search located no articles by professional economists dealing specifically with the question of electric utility advertising. However, a number of articles by professional economists were examined in some detail in the expectation of finding some discussion of the effects of electric utility advertising. Articles examined from this standpoint can be separated into three categories on the basis of their content. First, there are those that deal with regulations' effects on the behavior of the firm [12, 14, 24, 104, 167, 169, 179, 198, 246]. Second, there are those articles that deal with the pricing of output by utilities [31, 68, 88, 90, 93, 101, 105, 168, 190, 206, 237]. Finally, there are those articles that deal with the economics of regulation [42, 60, 99, 114, 124, 134, 144, 186, 203]. None of these authors gives the question of electric utility advertising more than passing notice. However, these articles are referred to in greater detail in developing some relevant facets of electric utility economics in Chapter II.

## Literature Search: Summary and Comments

The major conclusion of the literature search is that there is not much literature on the topic of the effects of electric utility advertising. This lack of research interest seems strange when one considers the amounts which residential consumers spend for electricity and the environmental and conservation problems associated with the rapid growth in the residential demand for electricity. The lack of research interest in the sales effects of electric utility advertising was attributed to a number of factors, including: 1) the fact that pollution and natural resource consumption by the electric power industry have reached alarming levels only in recent years; 2) the seemingly small magnitude of advertising expenditures by electric utilities; and 3) the fact that students of marketing have been more interested in the development of general theories of marketing behavior than in the study of special marketing problems in recent years.

Seven articles and one set of Congressional hearings, dealing specifically with the question of electric utility advertising, were found in the literature. The articles deal either with the facts of electric utility advertising or with the possible benefits of such advertising. None of these authors provides empirical evidence in support of the conclusions reached or assertions made.

Congressional hearings on the subject of utility promotional practices were strictly fact finding in nature and did not consider the possible impact of electric utility advertising on the residential demand for electricity. It was also noted that the Federal Power Commission has not supported any serious studies of the effects of electric utility advertising. Material cited in this section will be considered in greater detail in the extended literature search of Chapter II.

## Research Design

### The Advertising-Sales Relationship

Two hypotheses were stated earlier. First it was hypothesized that advertising by electric utilities has had an insignificant influence on the residential demand for electricity. Further, it was hypothesized that the growth in residential electricity sales over the past two decades has been largely determined by factors outside the control of individual electric utility firms. More specifically, it was suggested that residential electricity sales are a function of the following factors: residential appliance stocks; consumer income; weather conditions; competitive factors, including pricing and promotional policies of natural gas companies;[1] the price of electricity; and the advertising activity of electric utilities.[2]

### Per capita sales

It was determined that it would be more meaningful to measure residential sales on a per customer or a per household basis than on an aggregate basis. Leabo, in the following passage, has provided the major reason for using per capita rather than aggregate data to study economic relationships [123, p. 446]:

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[1] Data problems precluded the formal inclusion of competitive factors in the model.

[2] Variables are listed in order of their decreasing importance as sales determinants.

> If the study of economic relationships is most important, the correlation of per capita data is recommended, the reason being that population growth is the dominant component in many dependent variables of interest to the economist. Using per capita data tends to remove the strong influence of the growth of the economy due simply to the trend of population changes.

One would expect to find a close relationship between number of customers and total sales in both time-series and cross-sectional studies. The point is that the strong, and wholly expected, relationship between total sales and the number of residential customers would tend to obscure the effects of other more interesting sales determinants.[1] The relationship between total sales and number of customers is not of interest in this study because it has already been established and because population is a factor outside the control of public policy makers and the electric utility industry.

The solution is to examine the relationship between per customer advertising and per customer electricity sales. Where appropriate, all other hypothesized sales determinants are converted to a per customer basis.

### Using multiple regression

It is argued that per capita sales are a function of per customer stock of residential appliances, per customer income, weather conditions, the price of electricity to residential customers, and per customer advertising expenditures.[1]

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[1] The number of residential electricity customers is, of course, closely related to the size of the population.

The next question relates to the selection of some technique to test the validity of the hypothesis. Multiple regression analysis was selected because it is the statistical technique best suited to this particular task.[2] Multiple regression provides a means for measuring the degree of association between the dependent variable (sales) and the independent variables (hypothesized sales determinants). Multiple regression also provides a means of measuring the relative impact of each of the hypothesized sales determinants on per customer sales.[3]

The use of multiple regression analysis is approached with full knowledge of the many pitfalls involved. Discussion of the specific problems involved in the use of multiple regression analysis are presented later in this chapter and in Appendixes H and K. It should be noted here that it is recognized that association (correlation) between two variables does not prove that a causal relationship exists. However, it can be argued with equal force that "...causation does imply association" [84, p. 329]. Association (correlation) is therefore a necessary but not a sufficient condition in the demonstration of a causal relationship between two variables.

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[1] Remember that it was suggested that the effect of advertising on sales is insignificant and that the other factors, listed in decreasing order of importance, are the major determinants of residential electricity sales.

[2] See Appendix C for a justification of this statement.

[3] See Appendix O for a discussion of the various statistics obtained from regression analysis.

The question is, how does one determine when a true causal relationship exists? Green suggests the following approach [84, p. 330]:

> ...the imputation of a causal relationship between two or more associated variables must rest on extrastatistical considerations and the judgement of the analyst; he must assess the reasonableness of the relationship and reach a conclusion as to whether causation exists.

Along these same lines Wentz has made the following comment [235, p. 314]:

> Regression analysis determines the statistical correlation if any, between variables. However, correlation is not causation. The model must withstand certain statistical tests and be consistent with economic theory and common sense before it can be accepted as a reasonable analogue of reality.

In the case of this study the model is developed on the basis of theory and logic. The causal links between the independent variables (residential electricity sales determinants) and the dependent variable (per customer residential electricity sales) are established on theoretical or logical grounds and then, and only then, is multiple regression applied to test the model.[1] Multiple regression is used as a tool to measure the degree of association between various independent variables and the dependent variable, and as a tool to measure the effects of changes in the independent variables on the dependent variable.

Using both time-series and cross-sectional data

The major hypothesis was stated in the form of a model in the previous section. Namely, that per customer residential electricity sales are a function of the per customer stock of home appliances, per customer income, weather conditions, the price of some quantity of electricity, and per customer advertising expenditures. This model is tested by applying multiple regression analysis to both time-series and cross-sectional data.

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[1] A detailed exposition of the model and the causal links between the various independent variables and the dependent variable is presented in Chapter III.

The time-series analysis employs aggregate sales and sales determinant data for the entire privately owned electric utility industry for the years 1951-1970.[1] Multiple regression and simple observation are employed to examine the relationship between per customer residential sales of electricity and the hypothesized sales determinants. Special attention is, of course, paid to the advertising-sales relationship.

The time-series analysis is necessary from the standpoint of gaining some historical perspective on the relationship between per customer residential electricity sales and the hypothesized sales determinants. This analysis is approached with full knowledge of the rather severe problems, particularly autocorrelation and multicollinearity, often encountered in multiple regression analysis of aggregate time-series data.[2] These problems may cause the regression estimates to be biased. Certain tests will be applied to the time-series data to detect the presence of autocorrelation and multicollinearity. The outcome of these tests provides an indication of how much faith to place in the results of the time-series analysis.

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[1] Specific data series employed in the time-series analysis are discussed, along with their sources, in Appendix H. The actual time-series data are presented in Chapter IV.

[2] See Appendix G for a more detailed discussion of the problems encountered in the application of multiple regression to time-series data.

In the time-series analysis, the measures of association between the dependent variables and the independent variables,[1] and the measures of the relative influence of the various independent variables on the dependent[2] are the primary tests of the main hypothesis of this investigation.

Cross-sectional analysis is also used to test the major hypothesis of this study. The cross-sectional analysis employed in this study utilizes multiple regression and individual firm data to test the relationship between sales and the hypothesized sales determinants. First, a sample of 61 privately owned electric utilities, including 33 straight electric[3] and 28 combination[4] utilities, was selected.[5] Second, specific data series were selected to represent per customer residential electricity sales and the hypothesized sales determinants.[6] Next, these data are assembled for the firms in the sample and subjected to multiple regression analysis. Again, the measures of association between the dependent variable and the various independent variables, and the measures of the relative influence of the various independent variables on the dependent variable are the primary tests of the main hypothesis of this investigation.

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[1] These measures are the simple correlation coefficients. These measures are defined and discussed in Appendix O.

[2] These measures are the regression coefficients. These measures are defined and discussed in Appendix O.

[3] Straight electric utilities are those utilities which sell only electricity [34, p. 688].

[4] Combination utilities include those utilities which sell both electricity and natural gas [34, p. 688].

[5] Procedures used in selecting the sample are discussed in Appendix J.

[6] Specific data series chosen, the reasons for choosing them, and their sources are discussed in Appendix L. Actual cross-sectional data employed in the study are presented in Appendix M. It should be noted that data for the individual firms in the sample were collected for three different years -- 1965, 1967, and 1969. This provides some basis for comparing and evaluating the results obtained in a single year. If data for only one year were employed there would be no basis for determining whether the results obtained for that one year were representative or were an historical accident.

### Research design to test the major hypothesis: summary

The research design employed to test the relationship between residential electricity sales and the hypothesized sales determinants can be summarized briefly. First, sales, and where appropriate, the hypothesized sales determinants are stated in per customer terms. Second, causal links between the hypothesized sales determinants and residential electricity sales are developed from the standpoints of marketing theory, economic theory, logic, and relevant empirical evidence. Third, both time-series and cross-sectional data representing the variables in the model are assembled. Finally, multiple regression is applied to these data to determine the association between the various independent variables and the dependent variable and to arrive at some estimate of the relative effects of the various independent variables on the dependent variable.

## Other Effects of Electric Utility Advertising

In regard to the secondary purpose of this dissertation, it was hypothesized earlier that electric utility advertising has potential effects other than those related to electricity sales and production costs which may justify its use. It was further suggested that emphasis on the sales and cost effects of advertising has tended to obscure these other effects. Several advertising effects not related to sales or costs were suggested, including the following: 1) advertising by electric utilities provides needed market information, information regarding the proper and economical use of electrical appliances for example, to residential consumers of electricity; 2) advertising by electric utilities enhances the need satisfying ability of their service; 3) electric utilities do not enjoy monopoly status in all of the market segments they serve and advertising is, therefore, a necessary competitive tool.[1]

The research design for testing the various facets of this hypothesis is fairly simple. The first and second propositions are tested on the basis of marketing theory and the observed behavior of electric utility firms. Proposition three is tested by ascertaining certain facts in regard to the competitive behavior of the various types of firms competing for the residential energy market.

The informative role of electric utility advertising is evaluated in a three stage process. First, evidence is collected from the literature to establish, on a general level, the potential benefits which may accrue to the producer and to the consumer as a result of certain types of information provided to the consumer by the producer through advertising, Second, the informational needs of residential electricity consumers will be evaluated.

Finally, the possible sales and cost effects of informative advertising by electric utilities are considered. If it can be shown that residential electricity consumers have some need for information,

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[1] These questions are considered in greater detail in Chapter II.

information regarding the efficient use of appliances for example, a justification for electric utility advertising not necessarily related to costs is provided with some credence.

The question of electric utility advertising's ability to enhance the need satisfying ability of electricity is a more difficult one. First, the ability of advertising to enhance the need satisfying ability of products in general is evaluated from the standpoint of marketing and economic theory, and on the basis of a limited amount of empirical evidence. Second, the possibility that advertising by electric utilities can enhance the value of electricity service to residential consumers is explored. This possibility is evaluated on largely hypothetical grounds.

Finally, the hypothesis that advertising is needed by electric utilities as a competitive tool is considered. First, the nature of the competition for the residential energy market will be evaluated. The question is, do electric utilities face any significant competition for this market? Second, if it can be shown that electric utilities face significant competition for the residential energy market and that their competitors employ advertising as a competitive tool, it would seem to follow that electric utilities have some need to advertise.

In summary, the informative, competitive, and satisfaction enhancing aspects of electric utility advertising are considered in this dissertation. It is recognized that advertising has other effects than those related directly to sales and costs and that these other effects may justify the advertising expenditures of electric utilities.

It is not expected that the research design outlined above will provide a clear answer to this question. However, it is expected that this approach will provide a fairly clear indication of whether these arguments have any merit.

## Limitations of the Study

This study is subject to a number of limitations. Some of the limitations were imposed by the author to bring the study down to manageable proportions or in response to other practical considerations. Other, more serious, limitations are inherent in the mode of analysis, or analytical techniques employed or are due to data problems -- the unavailability of certain data or the quality of the data available.

### Time Focus

The analysis is limited in time to the 1951 to 1970 period. There are a number of reasons for selecting this period. First, beginning the study with 1951 means that some of the more serious effects of World War II distortions may be avoided. Bringing the analysis up to 1970 means that the study will be something more than a historical curiosity. Second, the 20 year period is long enough to show the industry under a variety of economic, social, regulatory, and technological conditions. In fact, it might be argued that the environment in which the industry operates changed so much over the twenty year period that it was not really the same industry in 1970 as it was in 1951.[1]

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[1] For a more detailed discussion of the changes in the environment in which privately owned electric utilities operated over the 1951 to 1970 period see Chapter IV.

### Geographic Limitation

The study is limited geographically to the continental United States. In a descriptive and exploratory study of this type it was felt that the scope should be broad. Constraining the analysis to a narrow geographic region would seriously restrict the generality of the findings, and of any conclusions that might be drawn from these findings. Criticism of a study confined to a narrow geographic area could be based on the possibility that the findings and conclusions are founded on nontypical data.

### Limited to Privately Owned Class A and B Electric Utilities

Privately owned electric utilities are those electric utilities owned by stockholders as opposed to those owned by federal, state or municipal governments [222, p. I]. Class A electric utilities include those electric utilities with annual electric operating revenues of $2.5 million or more [222, p. V]. Class B electric utilities include those electric utilities with annual electric operating revenues of more than $1 million but less than $2.5 million [222, p. V].

Besides the question of ownership, the important difference between privately and publicly owned utilities, in regard to this particular study, is the difference in their motives. According to Brandon, it can be assumed that the behavior of privately owned electric utilities is profit motivated [34, p. 689]. In contrast, publicly owned electric utilities have a tendency to persue goals completely unrelated to profit -- social goals, political goals, etc. [34, p. 689]. In pursuit of these noneconomic goals some publicly owned electric utilities, the Tennessee Valley Authority for example, have been known to sell electric power at prices considerably below the costs of producing it [34, p. 696]. It is suggested that differences in the motives of privately and publicly owned electric utilities tend to affect their market behavior and thus make comparisons between the two types of utilities confusing and perhaps misleading.

The study was limited to class A and B electric utilities for largely practical reasons. There are no operating or financial data available for electric utilities with annual electric operating revenues of less than $1 million. However, the ommission of these small firms should do no great harm to the conclusions of the study. In 1969, there were 212 privately owned class A and B electric utility firms in the United States [222, p. V]. These 212 firms accounted for 98 percent of the assets and revenues of the total privately owned electric utility industry in 1969 [222, p. VII].

The exclusion of publicly owned electric utilities and privately owned electric utilities with annual electric operating revenues of less than $1 million leaves a population of interest, for the cross-sectional analysis, which consists of 212 utility firms. In 1969, these 212 privately owned class A and B electric utilities accounted for 75 percent of all electric power generated in the United States [222, p. VII]. In the same year, privately owned electric utilities with annual electric operating revenues of less than $1 million accounted for less than 1 percent, municipally owned electric utilities accounted for 5 percent, federally owned electric utility systems accounted for 15 percent, and cooperatively owned electric utility systems accounted for 4 percent of the electric power generated in the United States [222, p. VII].

## Limited to Advertising - Residential Sales Relationship

As noted earlier in this chapter, the primary thrust of this analysis is limited to an examination of the relationship between advertising by privately owned electric utilities and their residential sales of electricity. The study is limited to the advertising segment of the total promotional mix for two reasons. First, advertising by electric utilities is the utility promotional activity which has received the greatest criticism from ecology groups, conservation groups, consumer groups, and from those concerned with power shortages [149, 172, 175]. Utility advertising has also been the subject of more regulatory action and concern than the other types of promotion employed by electric utilities [157, 175].

Second, even if one were interested in examining the relationship between nonadvertising types of utility promotion and residential electricity sales, data problems would preclude any kind of serious analysis. These data problems are of two types. The first data problem relates to the fact that though electric utilities serve three different types of customers -- residential, commercial, and industrial[1] -- they report only aggregate expenditures on various types of promotion [222, p. XXXV].[2] This method of reporting makes it impossible to determine how much of the various types of promotion were directed toward each of the various customer classes. Fortunately, this problem is not a serious impediment in regard to examining the relationship between electric utility advertising and residential sales of electricity. The problem is not serious in this case because nearly all utility advertising is directed toward residential customers [94, 110]. However, there is no reasonable way to allocate nonadvertising promotional expenditures between the various customer categories or, in other words, no way to determine how much nonadvertising promotional effort was expended on the different customer classes.

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[1] See Table 5 in Chapter III for a breakdown of the percentages of electric customers, unit sales, and revenues by customer class.

[2] See Table 4 in Chapter III for a breakdown of aggregate industry expenditures on various types of promotion.

The second data problem relates to the types of activity encompassed within the various categories used by utilities to report on their promotional expenditures. Utility promotional expenditures are reported by four broad categories, including: supervision, advertising expenses, selling and demonstration expenses, miscellaneous sales expenses.[1] Eighty percent of the total promotional expenditures of the average privately owned electric utility fell into the demonstration and selling, and advertising categories in 1969 [222, p. XXXVI]. Supervision and miscellaneous sales expenses each accounted for about 10 percent of the average privately owned electric utility's total promotional budget in 1969 [222, p. XXXVI].

Supervision expenses include "...the cost of labor and expenses incurred in the general direction and supervision of sales activities" [226, p. 101-189]. Miscellaneous sales expenses include "...the cost of labor, materials used, and expenses incurred in connection with sales activities which are not includible in other sales expense accounts" [226, p. 101-189]. The advertising expenses category includes those expenses which one would normally expect to find in connection with advertising -- media space expenses, copy preparation expenses, art expenses, etc. [226, p. 101-189].[1] The category demonstration and selling expenses includes expenditures on a potpourri of promotional activities, from commissions paid to salesmen for signing new industrial accounts to the costs of conducting cooking schools [226, p. 101-189]. Utilities do not report expenditures on the various specific activities encompassed within the supervision, demonstration and selling, advertising, and miscellaneous sales expense categories.

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[1] It should be noted that electric utilities are required by the Federal Power Commission to use a uniform system of accounts [226].

The above discussion indicates the existence of two data problems. First, utilities do not report how much of their total expenditures on the four types of promotional activity are directed toward each of the three types of customers they serve. Second, utilities report only total promotional expenditures in four broad categories. These aggregate expenditure data do not reflect the wide variety of promotional activities encompassed within the demonstration and selling expense category. As a practical matter the researcher has only total dollar expenditures on the four broad types of promotional activity to work with. This means that any attempt to examine the relationship between the various types of promotional activity and residential sales requires that the researcher be able to determine how much of the expenditure on a particular type of promotional activity was directed toward residential customers; and, since only dollar expenditures are available, that the researcher be able to assume that the activities within a given promotional category are relatively homogeneous.[1] Neither of these conditions can be met in the case of demonstration and selling expenses, however, they can be roughly met in the case of advertising expenditures.

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[1] The definition of advertising employed in this dissertation was provided in footnote 1, page 1.

[2] For a complete listing of all the items included in the various promotional expense categories see Appendix F.

Finally, the interest in the sales effects of electric utility advertising naturally restricts the study to the residential segment of the market. The main reason for this restriction is that nearly all utility advertising is directed toward residential customers [94, 110].

### Using Dollar Advertising Expenditures as a Measure of Advertising Intensity

A search of potential data sources indicated that the only measure of electric utility advertising intensity available from secondary sources is dollar advertising expenditures. Dollar advertising expenditures are employed in the analysis and their use represents a limitation because of the assumptions their use requires.

#### Same media mixes

The use of dollar advertising expenditures as a measure of advertising intensity, comparable between firms in a given year and over time, requires the assumption that all utilities use the same media mix[2] and that this media mix does not change over time [117, p. 75].[1] Though this may appear to be an unreasonable assumption, there is some evidence to suggest that the media mixes employed by utility firms are roughly comparable and that these mixes have not changed drastically over time. In a 1964 study, the Public Utilities Fortnightly staff found that of the 137 electric utility firms responding to their questionnaire, all 137 employed newspaper advertising, 134 employed radio advertising, 109 employed television advertising, and 101 employed outdoor advertising in their media mixes [94, p. 63]. This study showed only minor changes in the average media mix for firms in the privately owned electric utility industry over this period [94, p. 64]. In 1964 the average electric utility spent 58 percent of its advertising budget for newspaper advertising, 24 percent for television advertising, 11 percent for radio advertising, and 7 percent for outdoor advertising [94, p. 64].

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[1] This second point will be treated to a more extended discussion in the following section.

[2] The term media mix refers to a firm's relative employment of newspapers, direct mail, television, magazines, radio and other types of nonpersonal, paid media in its advertising strategy [127, p. 730].

The above findings show that most privately owned electric utilities utilize all four of the major media types in their media mixes. The above cited study does not show whether electric utilities spend relatively the same amounts on the different types of media.

### Same creative strategies

The use of dollar advertising expenditures as a measure of advertising effort also requires that one assume homogeneous units of advertising or advertising of equal creative quality, whether this comparision is made between firms at a tiven time or between firms over time

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[1] The comparision between firms at a given time applies to the cross-sectional analysis. The comparision between firms over time applies to the time-series analysis.

[117, p. 28].[1] It is, of course, impossible to justify the assumption that all electric utilities pursue exactly the same creative strategies in their advertising at a given time and that this strategy does not change over time. However, there is some basis to suggest that there has been an element of sameness in the creative strategies employed by electric utilities in their advertising over the past fifteen years. This sameness can be attributed to the Live Better Electrically Program (LBE). This program was initiated by the General Electric Company in 1956 and turned over to the Edison Electric Institute (EEI) in 1959 [35, pp. 36-40]. The costs of the LBE program were borne entirely by General Electric from 1956 through 1959 [35, p. 36]. From 1959 to the present the LBE program has been funded and administered by EEI [35, p. 37]. EEI is supported by the privately owned electric utility industry [35, p. 39]. The money to run the LBE program has, therefore, come from privately owned electric utility firms since 1959 [35, p. 39]. Individual utilities support the program on a formula basis. Firms in the industry pay either .15 percent of the first $10 million of revenues from residential sales and .125 percent of residential revenues over $10 million or a maximum $.12 per year per residential customer [35, p. 42].[1]

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[1] If utilities determined their entire advertising budget on such a formula basis one would expect to find a very high correlation between advertising and sales. However, the direction of causation would be reversed in that the level of advertising would be determined or would be some function of sales. Fortunately, for purposes of this analysis, a utility's contribution to the LBE advertising program amounts to only a small percentage of the utility's total advertising budget. The average privately owned electric utility's contribution to the LBE advertising program amounted to less than 7 percent of its total advertising budget in 1969 [222, p. XXXVI].

The LBE program has also included various types of marketing research. This research has included the identification and selection of advertising themes, including: flameless electric living, modern electric living, clean electric living, and others [35, p. 49]. In addition to using these themes in EEI national advertising, EEI has provided member utilities with material based on these themes to use in their own local advertising [35, p. 39]. Materials provided by EEI to member firms, include: mats for print advertisements, tapes for radio advertisements, and films and video tape for television advertisements [35, p. 39].

On the basis of the above discussion, it is suggested that there has been a degree of sameness in the creative strategies employed by privately owned electric utility firms.

### Summary: using dollar advertising expenditures

It was noted that dollar advertising expenditures are the only measure of utility advertising effort available from secondary sources. The use of dollar advertising expenditures as a comparable measure of advertising effort requires the assumption that utility firms spend these dollars the same way. Though utility firms certainly do not spend their advertising dollars in exactly the same way, evidence was presented which suggested that there is some similarity in the media and creative strategies employed by electric utility firms.

### Other Limitations

The study suffers from a number of limitations in addition to those discussed above. First, there are the limitations associated with multiple regression as a tool of analysis. These limitations were discussed earlier in this chapter and are discussed in Appendix G and Appendix K. Second, there are a number of data limitations. The various data problems are listed and discussed below:

1. Income data employed in the cross-sectional analysis are estimated and subject to considerable error. Details of income estimation procedures are discussed in Appendix M.
2. Weather data employed in the cross-sectional analysis leave something to be desired in that they represent readings taken at one geographic point but are used to represent the weather for broad geographic regions.
3. The lack of reliable data on the nonadvertising promotional expenditures of electric utilities made it impossible to consider the relationship between these expenditures and per customer sales.
4. The lack of data on residential natural gas prices in the areas served by straight electric utilities made it impossible to consider the effects of natural gas prices on the residential demand for electricity.
5. Lack of data on the number of homes in the service areas of utility firms that have electric heating or central electric air conditioning prevented consideration of the effects of these variables on the residential demand for electricity.
6. It would have been desirable to have sales and sales determinant data for units at the lowest level of aggregation, for individual households. Unfortunately, such data is not available from secondary sources and the

considerable funds necessary to generate primary data concerning the demand of individual households for electricity.

### Summary of Limitations

The limits and limitations of the study were discussed in this section. First, the investigation is focused on the 1951-1970 period. Second, the study is limited geographically to the continental United States. Third, the study is limited by type of firm to privately owned class A and B electric utilities.

In addition to these fairly standard limits on its scope the study is subject to a number of limitations in methodology and data. Dollar advertising expenditures with their fairly obvious limitations are the only available measure of relative advertising intensity from year to year and firm to firm. The cross-sectional analysis is based on a sample of firms rather than a census. The limitations of regression analysis and a number of data problems were also discussed.

The study is approached with full knowledge of the limitations discussed in this section. Although it is felt that none of these limitations represents an insurmountable obstacle, the results of the study must be interpreted in the light of these limitations.

## Plan of the Study

It was noted earlier that the major purpose of this research effort is to examine the relationship between advertising by electric utilities and their residential sales of electricity. It is recognized that examination of the relationship between residential electricity sales and advertising by electric utilities would require identification of all the important determinants of residential electricity sales and assessment of their relative effects on residential electricity sales.

The secondary purpose of this research is to examine considerations, other than those concerned with costs and sales, which might justify or condemn the use of advertising by privately owned electric utilities on the grounds of economic efficiency or economic equity.

The analysis is divided into four chapters; five chapters if the overall summary, conclusions and recommendations are counted. Chapter II attempts to satisfy the secondary purposes of the analysis, while chapters three, four, and five are concerned with the primary purpose of the analysis.

### The Second Chapter

In Chapter II several issues are considered and analyzed. First, the special economic and legal characteristics of electric utilities are considered. This first section of Chapter II includes an enumeration and discussion of the special characteristics of electric utilities; and consideration of the broad questions of economic efficiency and economic equity involved in the organization, operation, and regulation of electric utilities.

In the second chapter, the special conditions under which electric utilities advertise are presented and discussed. The third section takes up the bulk of the chapter an includes and exposition of the potential functions which might be served by electric utility advertising. In this section the various potential functions of electric utility advertising are evaluated hypothetically and from the standpoint of relevant secondary data. The potential functions of electric utility advertising considered include the following: advertising as a form of speech; advertising as a competitive tool for electric utilities;

advertising as a source of relevant product information for electricity consumers; advertising as a tool for increasing sales and decreasing costs; and advertising as a tool for enhancing the value of electricity service.

The objectives of this chapter are to establish two facts. First, that electric utilities are a special class of business requiring special consideration. Second, that electric utility advertising, like any advertising, has potential effects other than those associated directly with sales and costs.

This chapter is positioned directly after the introductory chapter for several reasons. First, it seems important that the special characteristics of electric utilities which distinguish them from other types of businesses are established early. Second, it also seems important to establish the fact that electric utility advertising has potential effects other than those related directly to sales and costs early in the study. The need to establish the effects of electric utility advertising not related to sales and costs takes on special importance when one considers that most of the anti-advertising action taken by regulatory commissions in recent years has been predicated on the notion that the only effects of electric utility advertising are those related to sales and costs.

### The Third Chapter

Chapter III is responsive to the primary purpose of this dissertation: examining the relationship between residential electricity sales and advertising by electric utilities. Chapter III serves as a prelude to the empirical analysis of Chapters IV and V in that it involves the development of some authority for the list of hypothesized sales determinants presented in Chapter I, the specification of a general model including sales and the hypothesized sales determinants, and the selection of a technique for data analysis.

Chapter III begins with a general discussion of models and their value as tools of analysis. Next, the general marketing sales model which has been suggested by McCarthy [131, 132] and others [117, 126, 188] is considered with a view toward applying it to the problem at hand. The remainder of the chapter, really the bulk of the chapter, involves the development of authority for a list of hypothesized sales determinants and the separation of the derived list into those factors which are generally under the utility firm's direct control and those factors which are outside the firm's control. Finally, some space is devoted to justifying the choice of multiple regression as the appropriate tool for analyzing and evaluating the model presented in chapter III.

### The Fourth Chapter

Chapter IV involves analysis of time-series data on sales and the hypothesized sales determinants for the privately owned electric utility industry for the 1951-1970 period. The main purposes of this chapter are to test the hypothesized relationships between sales and the sales determinants selected in Chapter III using aggregate time-series data for the industry and multiple regression. An important secondary objective of the chapter is to gain some historical perspective on the changes which have taken place in the industry over the 1951-1970 period.

The chapter begins with a discussion of general changes which have taken place in industry: supply, demand, number of customers, etc.

Next, changes in per customer residential electricity sales are compared with changes in the various sales determinant series in order to get some idea of the relationships between sales and the various sales determinants. Finally, the data are subjected to multiple regression analysis in order to arrive at some formal measure of association between sales and the set of sales determinants and relative measures of the effects of each of the independent variables on the dependent variable.

### The Fifth Chapter

Chapter V involves the analysis of the relationship between per customer sales and the hypothesized sales determinants for a sample of individual straight electric utility firms and a sample of combination utility firms. This analysis is performed for three recent years: 1965, 1967, and 1969.

The major objective of this chapter is to examine the relationship between average per customer sales and the hypothesized sales determinants for the firms in the sample. This analysis is of course carried out for purposes of testing the hypothesis concerning these relationships suggested earlier.

The chapter begins with a discussion of the procedures involved in selecting the sample. Next, specific data series are selected to represent the generalized sales determinants. Third, data assembled for the firms in the sample are subjected to preliminary analysis. This preliminary analysis includes observation of the relationships between sales and the various independent variables, computation of means and standard deviations for the series, and calculation of simple correlations between sales and the various sales determinant series. Finally, per customer sales and the remaining sales determinant series are subjected to multiple regression.

### Plan of the Study: Summary

The plan presented in this section represents the operationalization of the research design presented earlier in the chapter. As noted previously, Chapter II involves the identification of the potential effects of electric utility advertising and an exploration of the special economic and legal characteristics of electric utilities.

Chapters III, IV, and V are unified or related in the sense that they build toward the demonstration of causal relationships between certain variables and per customer residential sales of electricity and the demonstration of a lack of causal relationships between certain other variables and per customer residential sales of electricity. It is not expected that the research design employed in this study will produce absolute proof that some factors cause sales and other factors do not. It is expected that the research design employed in this study will provide a weight of evidence that certain factors have a significant effect on sales and others do not.

## Summary

A number of factors were discussed in this chapter including: the origin and purpose of the study, literature relevant to the topic, the research design for the study, the limitations of the study, and the organization plan to be employed in the study.

The study is prompted by the rapid growth in residential electricity sales. This growth has been responsible for rapid depletion of the nation's fossil fuel resources, considerable air and water pollution, and power shortages in certain parts of the country. These problems have prompted regulatory commissions in certain parts of the country to take action designed to stem the increases in the residential demand for electricity. These actions have centered around restrictions on the advertising and promotional activities of electric utilities. These actions would appear to reflect the fact that regulatory commissions implicitly assume that advertising by electric utilities has a significant effect on the residential demand for electricity.

The major hypothesis of this dissertation is that electric utility advertising does not have a significant effect on the demand. It is suggested that the residential demand for electricity is a function of the following factors: the stock of electrical appliances, consumer income, the price of electricity, and weather conditions. It was further suggested that the stock of electrical appliances in the hand of residential consumers is the most important single determinant of residential electricity sales. The research design to test these hypotheses involves several steps. First, causal links between sales and the various hypothesized sales determinants are developed on the basis of logic, theoretical considerations, and other research studies. Second, these relationships are explored using time-series data and multiple regression. Third, these relationships are examined using cross-sectional data and multiple regression analysis.

In addition to the major hypothesis, discussed above, it was also suggested that electric utility advertising has a number of effects other than sales effects. Some of these other effects are desirable and the total prohibition of electric utility advertising would rob consumers of their potential benefits. The effects of electric utility advertising not directly related to sales are considered in Chapter II.

## Chapter II

# AN EVALUATION OF THE POTENTIAL EFFECTS OF ELECTRIC UTILITY ADVERTISING AND OF THE SPECIAL CHARACTERISTICS OF ELECTRIC UTILITIES

## Introduction

The hypotheses, research design, and methodology of the study were outlined in Chapter I. This chapter can be divided into two major sections. In the first section, the special economic and marketing characteristics of electric utilities are considered. The second part of this chapter deals with the potential functions or effects of electric utility advertising.

Several objectives are pursued in this chapter. First, the secondary hypothesis of this study will be tested. The secondary hypothesis is that there are considerations, other than those related to the cost and sales effects of advertising, which may justify the use of advertising by electric utilities. Specifically, the informative, free speech, satisfaction enhancing, and competitive facets of electric utility advertising are considered.

The second objective of this chapter is to set the stage for the empirical analysis of the relationship between electric utility advertising and electric utility sales which is to follow. The stage will be set for this analysis by evaluating, from a hypothetical standpoint, the various ways in which electric utility advertising might affect electric utility sales. The cost effects associated with the various sales effects are also considered.

The third objective of this chapter, based on a more sweeping literature search than the one presented in Chapter I, is to provide an evaluation of the special economic, marketing, and legal aspects of electric utilities.

## Special Economic and Legal Characteristics of Electric Utilities

The economic, marketing, and legal powers and constraints under which electric utilities operate are much different than those under which nonregulated firms operate. In this section these differences and some of the reasons behind them are discussed.

### Distinguishing Characteristics of Electric Utilities

Garfield and Lovejoy have provided the following list of characteristics which distinguish electric utilities from other types of businesses [76, p. 1]:

> 1. Utilities operate as monopolies with government approval.
> 2. Electric utilities supply a service which for some uses has no close substitutes.
> 3. Electric utilities are subject to public regulation of their prices and profits.
> 4. Electric utilities must serve every financially responsible customer in their service areas, at reasonable rates, and without unjust discrimination.
> 5. A public utility may not enter a new market (geographic area), or abandon an existing market without the consent of public authority.
> 6. Finally, public utilities are granted by law the power of eminent domain. This power permits the utility to force, through court action if necessary, the sale of private property which it may need to serve the public.

The question is, why have electric utilities by law been granted these extraordinary powers and been subject to these extraordinary constraints? The answer lies largely in the economics of the situation. It will be shown that electric utilities have been granted monopoly power by law because of the dictates of economic efficiency. Electric utilities are subject by law to public regulation because of the dictates of economic equity.

## Electric Utilities and Economic Efficiency

Garfield and Lovejoy have noted that "...the outstanding economic characteristic of electric utilities is that they operate at greatest efficiency as monopolies" [76, p. 15]. They go on to make the following observations [76, p. 15]:

> It has long been recognized that it is in the public interest to authorize only one public utility the exclusive right to supply one or more services to a particular market. Compelling economic and physical factors rule out all but the monopolistic form of market organization in the supply of local public utility services. As a result, public utilities are termed "natural monopolies." As such they are the outstanding exception to the generally competitive nature of our economy.

What are these compelling economic and physical reasons which rule out all but the monopolistic form of market organization in the supply of local public utility services? First, and foremost, there is the fact that electric utilities experience decreasing costs of production [163]. According to Phillips, there are three aspects to these decreasing costs of production. These three aspects are discussed in the following passage [155, p. 22]:

> The first is short-run decreasing cost. This reflects the fact that once an investment in facilities is made, output can be increased with unit costs declining until the physical capacity of the facilities is reached.
>
> The second aspect of decreasing cost relates to the long-run. This phenomenon arises from the fact that, at any point in time, the unit cost of adding capacity declines as the size of the additional facility increases. Note that whereas the short-run decreasing cost situation relates to fuller utilization of existing capacity, the long-run decreasing cost situation applies to the economies associated with larger rather than smaller additions to capacity.
>
> The third aspect of decreasing cost reflects the fact of technological progress. Note that the second aspect is basically a static concept; at any point in time, with given technology, larger capacity increments tend to be associated with lower unit costs. But this third aspect of decreasing cost is dynamic: as technology changes, the real costs of adding capacity decline.

Many industries are characterized by decreasing short-run costs [155, p. 22]. The fact electric utilities experience decreasing production costs in the short-run, therefore, does not provide a compelling economic reason for them to be organized as monopolies. However, the decreasing long-run cost situation is much less common and dictates that monopoly is inevitable in the case of electric utilities. This point is demonstrated graphically in Figure I.

Figure I assumes constant technology and decreasing long-run costs. If four equal size electric utility firms served a given market, each employing a single electric generating plant, the long-run price could not be less than $P_3$ (plant size 1). If two equal size firms were to serve this same market from two plants, the long-run price could be as low as $P_2$ (plant size 2). This situation would, however, be unstable "...for if economies of scale permitted one of the firms to double the size of its plant, it would be able to supply the entire market (plant size 3), charging price $P_1$ and earning a monopoly profit equal to $P_1$CBA"

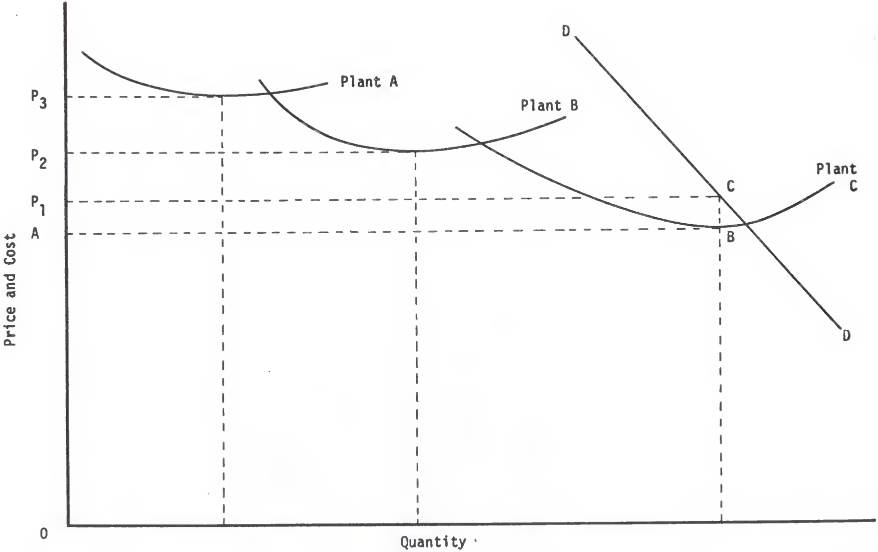

FIGURE 1

THE NATURAL MONOPOLY SITUATION

[155, p. 23]. The following comment summarizes the situation [155, p. 23]:

> The inherently noncompetitive market situation, therefore, is determined by economies of scale. Competition may exist for a time, but only until bankruptcy or merger leaves the field to one firm. Competition is self-destructive and results in a waste of resources. Conceivably, the two or three firms could make an agreement to share the market. Neither the firms nor the public would benefit should this occur. The firms would be high cost producers, and the consumers would be denied the benefits derived from economies of scale.

The validity of the above observations is confirmed by the utility history of almost all the major cities of the United States and Europe [76, p. 5]. This history is outlined in the following passage [76, pp. 15-16]:

> Before and around 1900 it was common to find more than one utility company serving the same service in a particular city. The situation invariably resulted in price wars between the utilities in a drive to get and keep customers. The quality of service provided by utilities thus engaged was ordinarily inferior and sometimes irregular. In addition, wasteful and costly duplication of facilities usually resulted. The outcome of price wars among the first utilities, it is important to note, usually was an agreement to end the ruinous competition and to join forces in a combination of the companies.

Blodgett makes similar observations in the following passage [30, p. 245]:

> Even if they begin to operate under competitive conditions, public utility companies tend to reach the monopoly form in the end, for in an effort to attract business the various competing companies tend to cut rates on each other until all companies save one are eliminated or until the competing firms see the error of their ways and decide to combine.

In summary, it is argued that monopoly is the inevitable outcome of competition between electric utility firms for a given market area. Monopoly is inevitable because monopoly is most efficient. Monopoly is most efficient because electric utilities experience decreasing costs in both the short- and long-run. Short-run decreasing costs are associated with more intensive utilization of fixed facilities [125, 243, 244]. Long-run decreasing costs for electric utilities come from two sources. First, larger electric generating plants tend to be more efficient than smaller ones [229, p. 252]. Second, "...at any point in time, the unit cost of adding capacity declines as the size of the additional facility increases" [155, p. 22].

Finally, it has been suggested that physical limitations alone indicate that public utilities are naturally monopolistic. The nature of these physical limitations is discussed in the following passage [76, p. 16]:

> ...there are undeniable physical limitations which argue against allowing more than one supplier of each utility service to operate in any city. Electric and telephone company poles and underground conduits and cables occupy choice and strategic land sites in metropolitan areas and along our highways. It is not hard to imagine the obstructions which would be created by a duplication of utility company facilities -- along and beneath our streets. Consequently, physical limitations indicate that public utilities are naturally monopolistic.

In conclusion, it is argued that, from the standpoint of economic efficiency, monopoly is the desirable form of market organization for electric utilities. The logic behind this conclusion is summarized in the following passage [229, p. 203]:

> An electric utility enjoys such great economies of scale that it produces on the declining part of its long-run cost curve. If two companies were to do business in the same area, each one would produce less. Each would therefore be farther up and to the left on its cost curve. The total costs of the two together would be higher than if there were only one firm.

## Electric Utilities and Economic Equity

In the previous section, it was argued that electric utilities operate most efficiently as monopolies. However, it must be noted that there are some obvious conflicts between the dictates of economic efficiency and the realities of economic equity. While monopoly insures the production of electricity at lowest average cost, monopoly does not insure that these cost reductions will be passed on to electricity consumers. This point is discussed in the following passage [155, p. 23]:

> ...the mere fact that a monopolist is allowed to exist does not assure the public of obtaining the benefits of whatever lower costs are achieved. In fact, the monopolist might absorb not only the benefits resulting from the lower cost but also might raise prices.

The dilemma between the dictates of economic efficiency and the realities of economic equity is discussed below [76, p. 16]:

> Once public utilities came to be recognized as natural monopolies, a genuine dilemma presented itself. How could the public achieve the benefits of lower average cost monopoly production of utility services without being forced to pay the prices that these monopolies command for their indespensable services?

The question was, again, how could the public achieve the benefits of lower cost monopoly production without being forced to pay the prices these monopolies could command for their indespensable services? The answer was that some sort of public control might be used to do the job. Phillips discusses this point in the following passage [155, p. 4]:

> ...if economic power is not to be controlled by the market, it must be controlled by public authority, for a firm's contribution to the general welfare, rather than being the result of voluntary choice, must be compelled.

Public policy makers were, thus, presented with a problem. Monopoly had proven to be the inevitable and, from the standpoint of economic efficiency, desirable outcome of competition between electric utility firms. However, this outcome brought with it an undesirable concentration of economic power in the hands of the monopoly utilities. This situation demanded some substitute for the constraints normally imposed by competition [76, p. 16]. Two avenues to controlling the economic power of monopoly electric utilities were available: public ownership or public regulation [19, pp. 1-22]. The country, as a matter of observed fact, opted overwhelmingly for private ownership and public regulation of electric utilities. In 1969, 76 percent of the nation's electric power industry was privately owned and publicly regulated [222, p. VII]. Twenty percent of the industry was publicly owned[1] and four percent was cooperatively owned in that same year [222, p. VII].

The preference for private ownership and public regulation over public ownership, evidenced in the above statistics, can be attributed to two factors. First, there is the general belief in this country that a competitive, free enterprise system is the best means of achieving our basic economic goals, including an efficient allocation of resources, a higher standard of living, and the preservation of personal freedom [3, p. 195]. It is suggested that belief in the above principles prejudiced the choice of a scheme to control the economic power of monopoly utilities in favor of one which would retain private ownership [76, pp. 15-17].[1] This goal was achieved by subjecting privately owned electric utilities to public regulation. Private ownership is retained while public regulation is employed "...as a substitute for competition" [76, p. 16].

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[1] Seventy-five percent of the publicly owned electric utility industry is owned by the Federal government, while 25 percent is owned by various municipal governments [222, p. VII].

Second, the Munn v. Illinois decision, handed down by the Supreme Court in 1877, provided the legal right of a state to regulate monopolies which provide a vital service to the public [76, p. 4]. Although this particular case involved the right of the state of Illinois to regulate the activities of grain elevators in that state, this situation and the situation under which electric utilities operate were so great that the Munn v. Illinois decision became the basic legal precedent for the right of a state to regulate the activities of electric utilities that operate in that state [19, pp. 2-4].

In summary, it was argued earlier in this chapter that monopoly is the inevitable outcome of competition between electric utility firms. It was also argued that electricity is produced at lowest cost when only one firm serves a particular area. In this section, it was argued that, though monopoly tends to insure lower average costs of production, there is no guarantee that these cost savings will be passed on to consumers. In fact, the monopoly utility is in a position to extract exhorbitant prices from consumers for its indespensable service. This situation called for some sort of public control of the economic power of monopoly utilities. The country has generally opted for private ownership and public regulation of electric utilities. It is argued that this approach retains the efficiency of private enterprise and monopoly, while placing adequate curbs on the economic power of monopoly utilities. In other words, it is felt that this approach insures that consumers will receive at least some of the benefits of low cost monopoly production of electricity without having to fear exploitation by utilities.

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[1] Nearly all of the Federally owned electric power system was developed in conjunction with various water control projects [34]. The Federally owned system has been widely used to provide low cost power (sometimes at prices lower than the cost of producing it) to encourage the economic development of depressed areas [34]. The pricing policies of the Tennessee Valley Authority provide the prime example of this policy.

## Basics of Electric Utility Regulation

Although the mechanics of electric utility regulation are dealt with in greater detail later in the study, an outline of the nature of this regulation is in order at this point. First, forty-eight of the fifty states have regulatory commissions which regulate the activities of electric utilities in the particular state. The only exceptions to this mode of regulation are Minnesota and Texas. In these states each city has some sort of regulatory body with the responsibility of reviewing the rate structure of the electric utility which serves that city [34].[1] In the other forty-eight states the state regulatory commissions try to regulate the behavior of electric utilities by controlling two basic aspects of their operations: the prices utilities can charge for their service and the rate of return that utilities are permitted to earn on their investment [14, 124]. The factors involved in the rate of return calculation are summarized in the formula [124]:

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[1] Municipal regulation has proven to be less effective than state regulation [169].

$$r = \frac{R - O}{V - D}$$

where: R = total revenues
O = operating expenses
V = value of utility's assets devoted to serving the public
D = accumulated depreciation on the above assets

The state regulatory commission sets r at some reasonable level. A reasonable level is supposed to be one that is neither so low as to exploit the utility's owners nor so high as to exploit the utility's customers [157]. The rate must be high enough to permit the utility to attract capital from private investors [14]. Once r has been set, based on the above criteria, the utility must submit a proposed schedule of prices [157]. This schedule must show how much the utility is going to charge the various types of customers (residential, commercial, industrial) for varying amounts of electricity. Along with this proposed rate schedule the utility must submit an estimate of the total revenues which this rate schedule will produce (R) and an estimate of operating expenses (O) in the coming fiscal year [157]. Finally, values for V and D are required to permit a calculation of r under the proposed rate schedule. Once the commission has decided on some particular policy -- original cost, replacement cost, market value -- for calculating the value of the utility's assets and some particular policy -- straight-line, or some form of accelerated depreciation -- for depreciating those assets the determination of V and D becomes a routine procedure [76, pp. 56-114]. Once V and D are determined the estimated rate of return under the proposed rate structure can be calculated and the proposed rate structure can be evaluated for its reasonableness in light of the rate of return constraint. If the rate structure does produce an estimated rate of return in line with the allowable rate of return, the commission has only to evaluate the reasonableness of revenue and expense estimates, and determine whether the proposed rate schedule is grossly unfair to any particular class of customer [76, pp. 249-259]. If everything falls into place the proposed rate structure will be approved [157]. If the commission has serious reservations about revenue estimates, expense estimates, or the fairness of the rate schedule adjustments will be made if the utility cannot show that these reservations are unwarranted [155, pp. 260-302]. The burden of proof always rests upon the utility [155, pp. 260-302].

This brief discussion serves as an introduction to the mechanics of the regulatory process. Specific aspects of this process, particularly those which relate to the determination of utility advertising budgets, will be discussed in greater detail later in the study.

## Electric Utilities Advertise Under Special Circumstances

It is suggested that electric utilities advertise under special circumstances, circumstances different than those under which nonregulated, nonmonopoly firms advertise. The crux of these differences lies in the fact that the residential consumer of electricity has either no choice or a very limited choice in regard to satisfying his various energy needs.

In the case of most purchases, consumers can choose how much advertising they wish to buy with the product -- at least they have the potential of so choosing [44, 196, 200]. The basic point is that advertising and commodities are supplied jointly and that the buyer has to pay for both even though he may want only the latter. The buyer who wishes, according to Stigler, can [196, p. 184]

> ...search out the seller who advertises little (but, of course, enough to be discoverable), and the latter can sell at prices lower by the savings on advertising.

The problem, from the standpoint of this research, is that this option is not available to the purchaser of electric power. The discussion below serves to illustrate this point. In the case of most purchases, the consumer has the option of buying a manufacturer[1] or dealer[2] brand. For example, the shopper can buy a nationally known and advertised brand of, say, peas or a can of peas, perhaps packaged by the same manufacturer, under the same standards, bearing a dealer brand [132, pp. 295, 692]. The dealer brand will typically be less expensive [87, 139, 142, 161]. Sometimes, of course, this difference in price can be explained on the basis of differences in quality [142, 200]. However, when quality is equal the dealer brand is typically less expensive than the national brand [87, 132, 145, 188, 196]. This difference in price is at least partly attributable to the national brand having to bear greater advertising costs per unit [132, 142, 188, 200].

A cursory examination of different industries shows considerable variation in advertising expenditures per dollar of sales and in creative strategies employed. These differences are found not only between industries, but also within given industries [7, 48, 127, 200]. When trying to decide what to buy to satisfy a particular need the consumer typically finds several business firms offering alternatives.[1] These alternatives differ not only in physical features but also, as noted above, in terms of the amounts and types of advertising associated with them. Alderson [6, p. 134] and others [63, 191] have argued that the consumer is typically in a position to exercise some choice as to the amount and type of advertising he wants by purchasing or not purchasing certain brands.

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[1] Manufacturers brands, sometimes referred to as national brands, have been defined by McCarthy to include those brands that are owned by manufacturers [132, pp. 294-295].

[2] Dealer brands, variously referred to as private distributor, and wholesaler-retailer brands, have been defined to include those brands that are owned and merchandised by wholesalers or retailers [87] [132, p. 294] [188, p. 240].

The residential buyer of electricity does not have this kind of choice. The residential consumer of electricity must use electricity for lighting, for anything electronic (radio and television), and for clothes washing [34, 134].[2] In the above areas the electric utility is a true monopolist.[3] The consumer of electricity cannot buy his electricity elsewhere, this consumer must take (and pay for) the quantity and type of advertising the utility provides [141, pp. 122-125].

Of course, it is not true that the consumer has no choice in regard to his total energy needs [34, p. 688]. There are a number of residential energy needs that the consumer can readily satisfy from any one of several sources. These needs might be referred to as discretionary energy needs. The most important of these needs involves water heating, space heating, air conditioning, cooking, refrigeration, and clothes drying [34, 134].

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[1] In the satisfaction of discretionary needs, leisure for example, the consumer not only has options between firms but also between industries. In the pursuit of leisure, the consumer might buy a boat, trip to Europe, set of golf clubs, etc.

[2] It should be noted that gas dryers, gas heaters, gas air conditioners, gas refrigerators, and gas freezers all require the use of some electricity to operate fans and motors.

[3] Blodgett has defined pure monopoly "...as a market situation in which the supply of an economic good, for which there is no close substitute, is controlled by a single seller while competitive conditions continue to prevail on the demand side of the market" [30, p. 954]. The utility's monopoly power is, of course, diluted by some regulatory board or bodies.

But even here, where the consumer has alternative means for satisfying energy needs, two factors work to limit consumer choice. First, most electric utilities actively court home and apartment builders for the purpose of persuading them to build units that use electricity as the sole source of power [134, 209, 233]. This persuasion typically takes the form of some promotional payment to the builder [209, p. 2]. This may be a cash payment, free appliances, or some combination of the two [208, 209, 220]. In any case, the dollar value of such payments, according to evidence gathered by a United States House of Representatives Committee, may range from five hundred to over one thousand dollars depending on geographic location and size of the house [209, p. 8]. Gas companies and, particularly, fuel oil dealers cannot afford to pay this much because of the economics of the situation [209, p. 62].[1] The consumer in the market for tract housing or an apartment, even though he may prefer gas or fuel oil heat, may find few units with other than electric heat [208, p. 48]. Second, most discretionary energy uses involve durable appliances which represent heavy capital outlays for the typical household. The average family is in no position to exchange electric appliances for those that use, say, gas in response to changes in market conditions or advertising they do not like [233, p. 37]. Thus, even in satisfying discretionary power needs the consumer's choice is limited.

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[1] The total electric home of 1700 square feet will use between $400-$650 worth of electricity in one year depending on the region of the country [208, p. A166]. There is no such thing as a total gas house. There are certain energy needs, mentioned earlier, for which gas is not substitutable for electricity. The annual gas bill for the 1700 square feet "all gas" house will be less than half the electric bill for a comparable all electric home.

The fuel oil dealer is even worse off in this respect [209, p. 3]. Not only is his fuel less versatile than gas but he also has to face direct competition. ABC Fuel Oil Company could hardly afford to pay contractor X $500 to put fuel oil heat in homes when the buyer is perfectly free to buy fuel oil from any of ABC's competitors [209, p. 3].

Several points have been presented concerning the residential user's lack of choice in regard to energy purchases. These points are summarized below.

1. For the satisfaction of part of his residential energy needs the consumer has no choice -- he must use electricity and pay for the amount and type of advertising provided with it.
2. For another group of his energy needs the consumer has a choice between natural gas and electricity.
3. For space heating and water heating the consumer has a choice between fuel oil, natural gas, and electricity.
4. It was argued, in connection with two and three above, that promotional payments to builders by electric companies have tended to mean that more all-electric homes are built than would otherwise be the case.
5. It was also noted that in the case of those uses for which electricity competes with other types of energy expensive durable appliances are involved. This means that consumers cannot readily switch from one type of

energy to another in response to changing market conditions.

It is argued that the above considerations establish advertising by electric utilities as a special case. These considerations put electric utility advertising in a different category than advertising by nonregulated, nonmonopoly firms. Every household must use some electricity but there is only one supplier. This coupled with the fact that electric utility pricing is essentially cost-plus pricing, means that advertising by electric utilities does not have to meet the market test that advertising by nonmonopoly, nonregulated firms has to meet.[1] Firms in the competitive sector advertise with the hope of attracting additional business. If this additional business is not forthcoming the competitive firm will ultimately have to reduce its advertising expenditures [127, pp. 495-517]. Again, it is suggested that utility advertising is not subjected to this market test and that its efficacy is, therefore, open to more serious question than is the efficacy of advertising by firms in the competitive sector of the economy. In the following section, electric utility advertising will be evaluated from a number of different perspectives.

## Potential Functions of Electric Utility Advertising

The secondary hypothesis of this study is that electric utility advertising may serve a number of different functions unrelated to sales stimulation which may justify its use. These other functions of electric utility advertising are identified and discussed in this section. In addition, the potential sales effects and cost impacts of electric utility advertising under various hypothetical conditions are considered in this section.

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[1] Cost-plus pricing is implied in rate of return regulation since operating expenses, including advertising expenditures, are subtracted from operating revenues to arrive at net income which is then divided by the depreciated value of the utility's assets to determine rate of return [203].

Four possible effects of electric utility advertising, not directly related to sales stimulation, were identified. First, the right of electric utilities to advertise might be linked with their right of free speech [71, p. 529]. Taking this view, one might argue that any attempt to restrict an electric utility's communication with its customers through advertising is an infringement on its right of free speech [71, p. 529]. Second, it can be argued that electric utilities are not pure monopolies and that they need to advertise if they are to effectively compete in the energy market [41, 110, 159, 162, 233, 242]. Third, it can be argued that electric utility advertising provides needed product and product use information to electricity consumers [42, 162]. Finally, it can be argued that advertising by electric utilities enhances the utility or the need satisfying ability of their service [224, p. 30]. These four arguments are evaluated in some detail below.

### Free Speech and Electric Utility Advertising

At least one defender of the right of electric utilities to advertise has attempted to link that right with the constitutional right of free speech [71]. It is suggested that this argument is a smoke screen. No responsible critic of electric utility advertising questions the right of electric utilities to communicate with the public through advertising or any other means [157, 177, 234]. For example, it would seem that an electric utility has a perfect right to defend itself through the use of mass media against the false or misleading charges of critics who by reason of office or reputation have access to the mass media [71]. The free speech rights of electric utilities are not really at stake [157]. What is really at stake is the right of electric utilities to pass all the costs of their advertising directly to their customers [157, 177, 234].

Electric utilities in all states but two are subject to rate of return regulation.[1] More specifically electric utilities are permitted some "fair"[2] rate or return[3] on their rate base.[4] Since advertising expenditures are deductible in arriving at net profit for rate of return computation, it might be argued that there is less incentive for advertising efficiency in the instance of electric utilities than in the case of nonregulated business firms. Oliver Williamson and others have suggested that there may be an incentive in the other direction [14, 16, 134, 136, 144, 203, 236, 238]. The hypothesis of this group is summarized by Williamson in the following passage [238, p. 250]:

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[1] Texas and Minnesota have no state commissions to regulate utility rates [34, p. 693]. Electric utilities in these states are subject to regulation by the various municipalities that they serve, but this type of regulation has proven to be weaker than that administered by state commissions [169, p. 178].

[2] The question of what constitutes a fair rate of return has been the subject of numerous legal proceedings. The fundamental basis for allowing a utility to earn a reasonable rate of return is found in the Fifth and Fourteenth Amendments to the United States Constitution [76, p. 117]. These two amendments provide limitations on the federal and state governments in that they are prohibited from depriving a person or corporation of property without due process of law. The precedent setting Smith v. Ames case established the rate base concept and spoke to the question of fair return as follows [187]:

> What the company is entitled to ask is a fair return upon the value of that which it employs for the public convenience.

The basic idea is that earnings are property and that earnings affect the value of property and that unreasonable restrictions of earnings through regulation represents deprivation of property without due process of law [76, 187].

[3] Rate of return is defined as net operating income expressed as a percentage of the rate base [76, p. 16].

[4] Rate base is defined by the Federal Power Commission as "...the net plant investment or valuation base on which the utility is permitted to earn a fair return" [220, p. 14].

> Since above normal profits can not long continue and since supernormal profits may invite the early attention of regulatory commissions, the management of a public utility that has other than profit-maximizing objectives has an incentive to hold profits at or below some "safe" level. This tendency to absorb profits is further reinforced by the fact that the penalty for inefficient operations is particularly weak among the regulated monopolies. Not only is there a virtual guarantee that rates will be set to cover costs and permit the utility to show earnings sufficient to attract new capital; in addition the regulatory commissions have not attempted to control costs. Hence there is a positive reward for absorbing profits without any offsetting penalty.

Williamson has also made the following observation based on his model of the business firm [238, p. 249]:

> In the presence of an excess profits tax,[1] for example, the behavioral firm will increase expenditures on advertising, customer services, public relations, and so forth and at the same time increase the proportions of management slack absorbed as cost.

Well before the fiscal year ends the electric utility, because of the predictable behavior of its revenues and expenses, has a good idea of what its net profits will be [115, 186]. If these estimates indicate a ten percent return when eight percent is the regulatory limit, the firm has a rate of return problem.

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[1] An electric utility is in a position, in regard to profits, roughly analogous to that of the firm subject to an excess profits tax [238, p. 250].

Lerner and Moag have suggested that the rate of return calculation for a utility might be expressed as follows [124, p. 404]:

$$r = \frac{R - O}{V - D}$$

where: R = total revenues
O = operating costs
V = value of the utility's assets
D = accumulated depreciation
r = rate of return on net assets
V-D = the rate base
R-O = net income

If the utility estimates that r (rate of return) is going to be larger than allowed, two basic courses of action are available.[1] The utility might increase its rate base (V-D) by an amount large enough to bring r into line or decrease net income (R-O) by enough to bring r down to the permissible level. Some combination of these two courses of action could, of course, be employed.

First, how does one go about increasing the rate base (V-D)? Little can be done with D (depreciation) in the short-run. What a utility may do in regard to depreciating its assets is tightly controlled by regulatory commissions [76, pp. 109-114]. Any increase in the rate base must come through increases in V. Building a new plant would certainly increase V, but new plants cannot be built at whim -- considerable planning is required. There is a lag of at least five years between conception and completion of such projects [225, p. 59]. More importantly, utilities do not build plants which involve long-range commitments (and perhaps idle capacity) to remedy short-run fluctuation in their rates of return [78, pp. 406-411].

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[1] The utility might decide, if the excess was not "large" to do nothing about it. Williamson has suggested that above normal profits can continue for some time while "supernormal" profits will, "...invite the early attention of regulatory commissions" [238, p. 250]. Averch and Johnson cite the case of the Bell System as an example [12, p. 1062]. In 1953 the Federal Communications Commission (FCC) set the Bell System's allowable rate of return at 6.5 percent. Bell earned more than this amount for more than a decade--up to an 8.5 percent rate of return in 1956--before the Federal Communications Commission took action. This phenomena discussed by Williamson and Averch and Johnson is referred to as "regulatory lag" and has been discussed along similar lines by Bailey and Coleman [15, p. 278], Baumel and Klevorick [24, p. 182], McKie [134, p. 8], Morrissey [144, p. 26], and Trebing [203, p. 25].

It is possible to make minor upward adjustments in the rate base by capitalizing certain items that might ordinarily be expensed [128, 129]. Utilities typically have the option of expensing or capitalizing certain maintenance expenses, certain labor charges involved in making plant modifications, additions to physical plant of less than \$1,000, etc. [129, p. 20]. Simple arithmetic shows that the immediate impact on rate of return will be greater if these items are expenses.[1]

The foregoing would seem to indicate that the regulated firm will not try to correct an excessive rate of return by making adjustments in the rate base.

The second possibility for reducing rate of return (r) to an acceptable level rests on the firm's ability to decrease net income

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[1] Assume V-D (rate base) equal \$100,000 and R-O (net income) equal \$10,000 giving an r (rate of return) of ten percent. Assume also a regulatory constraint in terms of an eight percent permissible r. Faced with a discretionary (expense or capitalize) item of \$1,000, the firm will face the following outcomes [60]:

$$\text{If item is capitalized:} \quad r = \frac{10{,}000}{101{,}000} = 9.9 \text{ percent}$$

$$\text{If item is expensed:} \quad r = \frac{9{,}000}{100{,}000} = 9.0 \text{ percent}$$

(R-O). Having previously defined net income as total revenues (R) less operating costs (O), two courses for reducing net income and consequently r are available: decrease revenues (R) or increase operating expenses (O).

The first course would involve voluntary rate reductions to customers and is seldom taken except in response to a long-run trend of excess profits. There is an observed desire on the part of regulated utilities to minimize the frequency of price changes [44, p. 56]. A decrease in rates this year to offset higher than allowable earnings may have to be followed by an increase next year. Frequent price changes could be a source of confusion to consumers and, thus, a source of bad public relations [44].

The second avenue for reducing net income involves the voluntary augmentation of expenses and particularly those expenses of a discretionary nature. If natural gas, for producing steam for electricity, is twenty cents per thousand cubic feet the electric utility will not volunteer to pay twenty-three cents in order to increase its expenses, decrease net income and thereby decrease rate of return. In the above case there is no conceivable benefit to the firm, but there are certain discretionary items such as advertising, increased staff, other emoluments, etc. where increased expenditures will not only satisfy the objective of decreasing the rate of return in the short-run but may also provide some benefits to the firm [238, p. 250].

In conclusion, it is argued that the argument that any attack against advertising by electric utilities is an attack on the right of free speech is a smoke screen. The issue appears to be a financial one rather than one of constitutional rights. Critics of advertising by electric utilities, for the most part, do not want to strip the industry of the right to advertise. These critics do question the fact that electric utilities are permitted to deduct their advertising expenses in arriving at their allowable earnings [177, 234]. In other words, critics question the system of regulation which permits electric utilities to extract the costs of their advertising from their customer whether that advertising is effective or not [177, 234].

### Electric Utilities are not Pure Monopolies

A second justification for advertising by electric utilities hinges on the argument that they are not pure monopolies.[1] A number of authors, including Corey [51, p. 46], Jones [103, p. 38], Kelly [110, p. 384], Kolb [115, p. 34], McKie [134, p. 14], Reif and Knoke [162, p. 36], Slesinger [186, p. 26], Welch [233, p. 33], and Wotruba [244, p. 23] have suggested that electric utilities are not entirely free from competition. This fact has also been recognized by regulatory commissions as the following passage indicates [158, p. 53]:

> It was contended before the Illinois commission that an electric company seeking a rate increase needed little or no advertising because it was certificated by various commissions to provide service in its

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[1] As noted earlier, Blodgett has defined pure monopoly, "...as a market situation in which the supply of an economic good, for which there is no close substitute, is controlled by a single seller while competitive conditions continue to prevail on the demand side of the market" [30, p. 954]. Electricity is put to many different uses in the home. In the case of some of these uses, such as lighting, it has no close substitutes. The electric producer is, therefore, a pure monopolist with regard to home lighting. This fact has been pointed out by Blodgett [30, p. 244], Brandon [34, p. 688], and McKie [134, p. 18]. There are several good substitutes for electricity (natural gas, fuel oil) in the case of space heating. Electricity producers are therefore not pure monopolists in the supply of energy for space heating. Discussions of this point can be found in Blodgett [30, p. 244], Brandon [34, p. 688], and McKie [134, p. 18].

> designated areas. Consequently, it was said, there was no other electric company to compete with the applicant. The commission observed, however, that the applicant company competes with other industries for heating customers and requires advertising to promote the use of various electrical appliances. Since the amount of the advertising budget in this case was well within the allowable amounts for companies of its size, the commission found the advertising expense claim proper.

Electric power companies are subject to significant competition on at least two levels:

1. In an indirect fashion, electric utilities must face the general competition for the consumers' discretionary dollar [110, 134, 162, 242, 244]. In a region of the country where air conditioning is not a must, for example, an individual consumer may have a hard time deciding between a new boat, a pool table, a set of golf clubs, a color television, or air conditioning for his home. A number of these examples could be given but the basic point is made, for nonnecessity uses the electric utility has to compete with all the other firms pursuing the consumers' discretionary dollar.
2. Second, in a more direct fashion, electric generating companies must compete with firms providing alternative types of energy [110, 134, 162, 242, 244]. Only for certain uses, noted earlier, is electricity a necessity with no close substitutes. In recent years there has been vigorous competition within the energy industry for certain critical market segments. There has, for example, been a very fierce contest for the space heating market between electric, gas, and fuel oil companies [103, 134].

The foregoing evidence would seem to establish the fact that electric utilities do not operate in a competition free environment. Given this fact, it follows that electric utilities must employ some amount of advertising if they are to effectively compete in this environment.

It seems worth noting that competition for new markets may benefit the present customers of electric utilities. For example, Baumol has made the following comments on the possible benefits of competition [23, p. 278]:

> ...a relatively low price in elastic markets, provided it covers more than incremental cost, may well permit lower prices in other markets and hence be beneficial to everyone. For (particularly if the firm is subject to a constraint on its overall profit) the opening of a market which makes any net contribution may permit or may even require a reduction in prices elsewhere.

In his testimony before the Dingell Commission, Baumol made the following comments concerning the use of lower than average cost pricing by electric utilities in connection with competition for the space heating segment of the market [208, p. 637]:

> ...increased sales which are made possible by rates which are low but still exceed incremental costs will not only help the consumers of the product in question, the consumers of the product whose rates have been reduced directly or indirectly, but where total returns are regulated, they will also help the consumers of other products provided by the same company.

Baumol has also noted that competition between the different energy types typically means price reductions and that "...low prices are the ultimate manifestation of effective competition" [208, p. 627]. Advertising provides not only a means to communicate to consumers the advantages of different types of energy, but also a means to tell them about such things as reduced rates for certain uses -- space heating for example [42, 134].

In summary, it is argued that electric utilities are subject to competition -- both direct and indirect. It is also argued that this competition may bring benefits to consumers in the form of lower prices for the energy they consume. Finally, advertising would appear to be a necessary tool for effective competition by electric utilities.

## Product Information

Numerous students of advertising, including Alderson [6, p. 80], Backman [13, p. 5], Bucklin [36, p. 11], Doyle [63, p. 579], Engel [67, p. 381], Farley [69, p. 370], Granbois [79, p. 44], Kernan et al. [112, p. 348], Sandage and Fryburger [170, p. 80], Stern [192, p. 49], Stigler [194, p. 200], Tesler [200, p. 540], and Warne [227, p. 63], have recognized advertising's role in providing product information to consumers. Information to help consumers choose between alternative means for satisfying their needs and to help consumers utilize the chosen product or service intelligently.

Bucklin has commented on the informative role of advertising in the following terms [36, p. 11]:

> The central market place facilitates the meeting of buyers and sellers interested in the exchange of certain products. Without such a common ground, both buyers and sellers must make extensive searches for suitable trading partners. The central market place helps minimize the cost of these activities. Advertising serves a similar purpose by providing information about the nature, availability, and location of products.

George Stigler has argued that "...information is a valuable resource," that advertising is "the obvious method of identifying buyers and sellers" which "reduces drastically the cost of search;" and, that "it is clearly an immensely powerful instrument for the elimination of product ignorance..." [195, pp. 213, 216, 220]. Thus there are a number of authorities that appreciate the consumer's need for product information and recognize advertising's role in providing this information.

More appropriate to the question at hand, Reif and Knoke [162, p. 34] and Caves [42, p. 172] have discussed the electric power consumer's need for information regarding the use of electricity and different electrical appliances. These authors have also noted that it is desirable that electricity producers provide such information to consumers through the vehicle of advertising. For example, Caves has spoken to this question in the following terms [42, p. 172]:

> Enough resources (and no more) should be devoted to sales promotion and providing information to consumers.

The material presented thus far could be advanced as possible justification for advertising by electric utilities. Such a case would, however, have two basic weaknesses. The first involves the information versus persuasion question; the second relates to the difficulty of determining just how much information the consumer needs.

### Information versus persuasion

Speaking to the first question, Caves has provided the following comments [43, p. 102]:

> At the point where advertising departs from its function of informing and seeks to persuade or deceive us, it tends to become a waste of resources.

Alderson draws a distinction between information and recommendation, but sees both to be essential services to the consumer in the following passage [6, p. 128]:

> Advertising messages carry two types of content which may be designated as information and recommendations. Both are essential services to consumers facing

> uncertainty in making purchase decisions. Some readers will object to the dichotomy on the grounds that the whole business of advertising is persuasion and that it should be defined simply as persuasive communication. The reply, made on the basis of modern learning theory, is that only those messages, whether carried through advertising channels or by other methods, are noted and retained which are related to the individuals expectations or his hopes and fears about the future. Hence all effective communication is persuasive, and we have not said much about advertising when we call it persuasive communication.

Alderson goes on to make the following observations [6, p. 128]:

> Information relates essentially to the nature of the product itself, how it is to be obtained and how it has been used in the laboratory or in consumer testing. If the advertiser is going to inform consumers, he can only tell them what he knows. When he gives consumers arguments about why they should buy his product, he is outside the realm of his knowledge and hence has no capacity for providing information.

Sandage and Fryburger see the issue a bit differently. In the passage below they point out that even the most honest attempt to impart information is likely to involve some persuasion and that persuasion requires the impartation of information [170, p. 80]:

> Advertising, in any form, contains within itself an element of persuasion. Advertising that is purely informative is often all that is needed to persuade a reader or listener to buy the product. In periods when some consumer goods have been very scarce, bare announcement by any local merchant that a shipment has been received is enough to produce a rush for the store. There is much persuasion in the one word "fire" when shouted with sincerity and truth to persons in a burning building.

The divergency in the comments of these different authors is cleared up to some extent in the following comment by Kernan et al. [112, p. 348]:

> To the critic, information is rather explicitly defined. It is data that facilitates a buyer's comparison of products according to their ability to satisfy specified needs. "Information

> advertising", for example, is of the specification type -- it tells what something looks like, how it performs, how much it costs, where to buy it, etc. On the other hand, showing a man on a surfboard as part of an ad for cigars, for example, adds no information and only confuses the issue. The businessman, however, sees such an ad as informative in that it suggests something about the kind of people who smoke cigars.

The divergence in the views of these different authorities, as pointed out in the above passage, can be largely attributed to their differing definitions of the term information. One can take a narrow view of the term, as does Caves, and exclude from the realm of information any communication that involves persuasion [42, p. 172]. Or one can recognize, like Sandage and Fryburger [170, p. 80], and Alderson [6, p. 128], that persuasion requires information and that naked information can be quite persuasive -- that the two (information and persuasion) are inextricably intertwined. This view is in keeping with Webster's definitions of the terms information and persuasion. Information is defined as "knowledge acquired from any source", knowledge is defined as "all that has been perceived or grasped by the mind", and persuasion is defined as "causing to do something, especially by reasoning, urging or inducement" [231, pp. 723, 1062]. It would seem, based on the above evidence, that the distinction between information and persuasion is not a useful one and that any attempt to draw such a distinction is doomed to failure. The broader view of information taken by Alderson [6, p. 128], Kernan et al. [112, p. 348], and Sandage and Fryburger [170, p. 80] seems to be the more realistic one in the light of the above discussion.

Certainly the process of judging the informative value of public utility advertising must, to some extent, be a subjective one. It is more a question of judging the value or usefulness of alternative types of information to consumers than of trying to decide what is informative and what is persuasive. The industry's failure to provide certain types of information was highlighted by William B. Shank, chairman of the Edison Electric Institute Marketing Executive Committee, in an address before the thirty-eighth annual convention of the Edison Electric Institute [66, p. 34]:

> I suggest, for example, that we do some positive marketing in the air conditioning field. Now, those of you with critical summer peaks may think I'm out of my head. But I am deadly serious. I pointed out earlier that the process of marketing goes on whether we like it or not; and if we are not positive in our moves and judgements, the marketing process will have a negative effect.
>
> Your customer knows he's hot whether you tell him or not. If he gets too hot, he is going to do something about it. If you haven't given attention to the marketing of air conditioners, chances are he is going right down to the store that advertises and pick up one of those bargain units which have a 10,000 Btu rating but draws 1,900 watts. Through wise marketing, you might well persuade him to buy a 10,000 Btu unit that requires only 880 watts. But if you haven't, just multiply that customer by 100,000 and you can have over 100 megawatts of needless excess on-peak summer load! Doesn't that sound as though it's worthwhile to give marketing attention to such applications?
>
> And not only does this type of marketing help reduce peak loads, it contributes in another important way. The man who buys the inefficient air conditioner is going to find it expensive to operate. The man who buys the efficient unit will find it both economical and quiet. Which customer do you think will continue to operate his unit when the weather is only moderately warm? Which one is going to continue to purchase energy from you to support the investment he has forced you to make? Which one is a better prospect for electric heating in the winter?

The point is that the well informed consumer is not only in a position to look out for his own best interests but may also serve the interests of the company he patronizes.

All of the authors quoted in this section -- Alderson [6, p. 80], Backman [13, p. 5], Bucklin [36, p. 11], Caves [42, p. 172], Doyle [63, p. 579], Farley [69, p. 370], Granbois [79, p. 44], Kernan et al. [112, p. 348], Sandage and Fryburger [170, p. 80], Stern [192, p. 49], Stigler [195, p. 200], Telser [200, p. 540], and Warne [227, p. 63] -- would agree that there is considerable value in telling consumers certain things about products and services. All these authors would agree that advertising of the specification type, "...that tells what something looks like, how it performs, how much it costs, where to buy it, etc." is helpful to consumers [112, p. 348]. To the extent that a particular utility advertisement provided such information, it would be judged to have a high content of useful information.

The above authors would also agree that false, misrepresentative, or misleading advertising has zero, or even negative, value to consumers. Disagreement exists in regard to advertising that falls somewhere between specification and misrepresentation -- advertising that appeals to the emotions. Caves [42], Stigler [195], Telser [200], and Warne [227] argue that such advertising provides no useful information to consumers and that its impact on wise consumer choice is negative. Backman [13], Bucklin [36], Doyle [63], and Kernan et al. [112] note that while critics may argue that "...showing a man on a surfboard as part of an ad for cigars, for example, adds no information and only confuses the issue" such an advertisement may be informative "...in that it suggests something about the kind of people who smoke cigars" [112, p. 348].

Along these same lines Sandage and Fryburger have noted that [170, p. 73]:

> Not all communication about products should be devoted to giving information about their physical properties. Many items are purchased or sought to provide psychological value.

Two examples serve to illustrate their point [170, p. 74]:

> Perfume for the lady could be advertised in terms of its chemical composition, its evaporation factor, and its low price, but these are not the basic elements for which women choose their perfume. Instead, they are seeking some hidden factor that will make them feel accepted and permit them to live on cloud nine even if only for a short time.

Referring to an advertisement for expensive glass crystal, Sandage and Fryburger make the following observations [170, p. 74]:

> Physical properties of glass are, of course, important to the buyer, but the buyer of glass for decorative purposes is more concerned with what the product will do for her "frame of mind" than with such elements as durability, specific gravity needs, space, weight, or fusion point. Primary values sought are psychological, and the advertiser has a responsibility to help guide the consumer in her search for psychological satisfaction.

Kernan et al. have made the following comments on emotional buying motives [112, p. 8]:

> The catalytic nature of promotion lies in its ability to render a seller's products or services meaningful to would-be buyers. Unless a consumer can perceive a product or service useful in achieving some personal or social goal (which may include pleasing others), he will not seek the product or service. What a product is (its meaning) varies according to who is perceiving it. It rests with promotion to ensure that the sellers product has meaning and that such meaning has positive value to the consumer.

There is, then, some evidence to suggest that people buy some products to satisfy emotional, psychological, and social needs. It can be argued that advertising showing how a particular product satisfies such needs may be quite useful to consumers. In response to those who criticize advertising that appeals to the emotions, Alderson has made the following comment [6, p. 128]:

> The reply, made on the basis of modern learning theory is that only those messages, whether carried through advertising channels or by other methods, are noted and retained which are related to the individuals' expectations or his hopes and fears about the future.

Alderson would seem to be saying that advertising can not create emotional needs but can only appeal to emotional needs that are already in existence. Critics would, perhaps, be on firmer ground if they criticized peoples' motives rather than advertising that appeals to these motives.

The preceding discussion does not provide a hard answer to the question of the usefulness of various types of information to electricity consumers. It does, however, suggest a rough taxonomy for classifying electric utility advertisements according to their content of information useful to consumers. This classification scheme is summarized in Table I.

### How much information do electricity consumers need?

The first question -- what kind of information do electricity consumers need -- has been considered. But what of the second question -- how much information do consumers need? There is no published research directly pertinent to this question. Studying advertising in general, Kaldor calculated that the specification type information presently being provided by advertising could be supplied at one-fifth the cost by an independent information service [106]. Similar conclusions were reached by the Maloney Committee on Consumer Protection [80], the Consumer Council [106], and the Reith Commission [106]. It should be noted that these studies are predicated on the

TABLE 1

SCHEME FOR CLASSIFYING ELECTRIC UTILITY ADVERTISEMENTS ACCORDING TO THEIR CONTENT OF USEFUL INFORMATION

| Advertising Approach | Useful Information Content |
|---|---|
| 1. Product Advertising[a] | |
| a. Specification | Moderate to High |
| b. Misrepresentation, False | Negative |
| c. Appeals to Emotion, Psychological Needs, Etc. | The Full Range--Negative to High[b] |
| 2. Institutional or Image Building Advertising [c] | Zero to Low |

[a] Product advertising is concerned with informing about or selling a product [132, p. 577].

[b] This is the only conclusion that can be reached after considering all the points of view presented in this section.

[c] Institutional advertising is intended primarily to develop goodwill toward the company. It does not involve a product or service [132, p. 577].

It should be noted that the classification problem is considerably complicated by the possibility of finding several of these approaches combined in a given statement.

assumption that specification type advertising is the only kind of advertising that provides useful information to consumers.

State regulatory commissions must face, at least implicitly, the question of how much information electricity consumers need when they review the appropriateness of utility advertising budgets. However, the criteria that have been historically applied by regulatory commissions in deciding on the appropriateness of these expenditures do not relate to the informational needs of electricity consumers but rather to what other electric utilities spend on advertising and to what the utility in question spent on advertising in the past [76, 157]. For example, the Arkansas commission reduced the allowable sales promotion expense for an electric utility under their jurisdiction after conducting a comparative study of the ratios of such expenses to total operating expenses for a number of electric utility firms [76, p. 53].

The question of how much information electricity consumers need is difficult to answer. If Kaldor's conclusion could be extended to the electric utility case it might be concluded that electricity consumers actually need considerably less information than they are presently paying for [106]. As noted above, regulatory commissions have not tried to answer this question directly. The commissions have tended to judge the appropriateness of a utility's proposed advertising expenditures from the standpoint of that firm's historical advertising expenditures and from the standpoint of the advertising expenditures of comparable electric utilities. No attempt to base electric utility advertising expenditures on the estimated informational needs of electricity consumers could be found in the literature. It should be noted that estimates indicate that 33 percent of all electric utility advertising is institutional or image building in nature, while 67 percent is sales promotional in nature [110, p. 393]. One might conclude on the basis of the above figures that only some fraction of 67 percent of all electric utility advertising is devoted to the provision of product information.

### Advertising Adds Value to the Product

A fourth argument, closely related to the consumer's need for product information, that can be advanced in support of advertising by electric utilities is that such advertising may add to the value of electricity service. Taking this approach one can argue that even if advertising does add to the product's cost the consumer may be compensated for this by a like or greater increase in expected utility[1] or expected satisfaction. Alchian and Allen have commented on this point in the following terms [3, p. 378]:

> The crux of the defense of advertising is the same as for any other economic activity. The defense of what seems to be wasteful advertising is that to others who pay for it, it does succeed somehow in affecting their utility or that of other people.

Commenting on public utility advertising Wotruba makes the following argument [244, p. 29]:

> Perhaps the main purpose of advertising can be summed up as follows: to increase sales by adding value to the advertised product or service. Value is added by informing and educating a consumer audience concerning the existence or correct use of

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[1] Baumol defines the utility of a commodity as "...the subjective benefit which the consumer obtains from its possession and use" [22, p. 180]. Along these same lines Bilas has commented that after purchasing a good the consumer "...obtains satisfaction from the possession of that good. That is, he derives utility from the possession of the good" [27, p. 37]. Mansfield, commenting on indifference curves, equates utility and satisfaction [137, p. 29].

> a product or service, and by explaining clearly how a given product or service can satisfy consumer's buying motives. The persuasive effect of advertising is seldom successful by itself, unless it is tied directly to one of the above purposes.

Kerman et al. [112, p. 32], Lipson and Darling [127, p. 11], Marquardt et al. [139, p. 45], Morse [145, p. 293], Sandage and Fryburger [170, p. 79], and Wotruba [244, p. 29] have all recognized advertising's potential to add value to products and services. These authors suggest that advertising adds value by reducing the risk[1] connected with consumer choice. Bauer has discussed the notion of risk in consumer decision making in the following terms [21, p. 389]:

> Consumer behavior involves risk in the sense that any action of a consumer will produce consequences which he cannot anticipate with anything approximating certainty, and some of which at least are likely to be unpleasant.

It is Bauer's thesis that consumers tend to make risk-minimizing decisions based on their perceived definition of the situation. The consumers' perception of risk in a given purchase situation, Bauer feels, is a function of the possible consequences and the uncertainty involved. Consequences can be thought of as payoffs if a given event occurs, and may include satisfaction beyond expectation, money loss, or disappointment if a new item does not live up to expectations. The uncertainty element can be thought of as the probabilities that these different consequences will occur [139].

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[1] The idea of risk perception by consumers in connection with the purchase of products and services has received empirical support from Arndt [10], Bauer [21], Cox [52], Cox and Rich [53], Cunningham [56], Marquardt et al. [139], and Popielarz [156]. To cope with the hazards of buying consumers develop risk handling strategies [21, 54, 67, 166]. Repeated purchase of the same brand is one such strategy [55]. A more active strategy is seeking additional information, through advertising for example, with respect to the decision problem [166].

Robertson has suggested that consumers try to cope with risk by increasing the probability of a favorable purchase outcome and, further, that consumers try to increase the probability of a favorable outcome or consequence by acquiring more information about the particular purchase situation [166, p. 22].[1] This information seeking may take the form of using marketer controlled sources such as advertising.

Various types of consumer risk, including functional, social, and psychological risk have been discussed in the literature. Financial risk has been discussed by Bauer [21, p. 389], Bucklin [36, p. 12], Dommermuth [61, p. 128], Engel et al. [67, p. 607], and Katona and Mueller [108, p. 46]. This type of risk is usually considered to revolve around the consumers perception of a product's ability to perform in a satisfactory manner [21, 67]. This type of risk is often referred to as functional risk [166, p. 21]. Social risk has been discussed by Bauer [21, p. 389], Engel [67, p. 384], Katona [109, pp. 289-290], and Robertson [166, pp. 21-23]. Social risk is limited almost exclusively to products that are visible[2] or conspicuous and is related to the individual's concern with what other people will think of him. Psychological risk has been discussed by Cox [54, p. 87],

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[1] Bauer has pointed out that some consumers also develop risk reducing decision rules [21, p. 390]. These include: buying only a certain brand, buying only nationally advertised brands, buying only the cheapest brand, buying only the most expensive brand, buying only a certain amount of the product, or buying only products with a plain and sensible design.

[2] Visibility means, according to Engel et al., that the product must be seen and identified by other people [67, p. 384].

Downs [62, pp. 6-12], Engel et al. [67, p. 386], and Robertson [166, p. 21]. Psychological risk is related to the individual's perception of whether a particular product will enhance his sense of well being or self concept [54, 166].[1]

Consumers may perceive a particular product to be high in one or any combination of the three types of risk [166, p. 21]. For example, Cunningham found headache remedies to be higher in perceived functional risk than fabric softeners or dry spaghetti [54, p. 87]. Robertson found that "...a new telephone product was low in perceived functional risk but fairly high in perceived psychosocial risk" [166, p. 21]. Robertson found that "...there was little concern with the phone not working (functional risk), but a good amount of expressed concern about what other people would think about the product (psychosocial risk)" [166, p. 22]. Robertson has also noted that some products by their nature, such as clothing, are high in psychosocial risk while others, such as drugs, are high in functional risk [166, p. 23]. Robertson cites automobiles as an example of a product that consumers generally perceive to be high in both functional and psychosocial risk.

It was noted that consumers develop strategies for handling risk and that general information seeking is the most common of these strategies. This leaves firms in a position to provide useful information to consumers. Advertising that provides specification type information would tend to help consumers reduce functional risk. Advertising that shows how the use of a particular product or service is compatible with the life styles of particular reference groups might be helpful in reducing social risk [109, pp. 289-290]. Finally, advertising that show how the use of a particular product or service is consistent with the satisfaction of certain psychological needs -- ego needs or self fulfullment needs for example -- might be helpful in reducing psychological risk for the consumer [166, p. 22].

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[1] These two types of risk -- psychological and social -- are sometimes combined into a single category and referred to as psychosocial risk [166, p. 21].

One might argue that in the case of electricity purchases the consumer faces little risk -- a kilowatt hour is a kilowatt hour, there is no doubt. This is true, but at various times the consumer faces choices between energy sources: when a heating unit needs replacing, when he buys a new home, etc. If advertising by electric power companies provides information that helps the consumer make the right choice from his economic, social, and psychological perspectives it has certainly been of value to the consumer.

### Advertising, Market Information, and Added Value: Other Views

Some students of advertising, including Bain [16], Caves [43], Galbraith [75], Kaldor [106], Masters [140], Packard [150, 151], Warne [227], and Weiss [232], though agreeing that consumers need information if they are to make intelligent purchase decisions, would argur that advertising does not provide information useful for that purpose or that advertising is an inefficient means of disseminating product information. Some of these critics, namely Bain [16, p. 390], Caves [43, p. 102], and Kaldor [106, p. 6], argue that the advertising competition which naturally develops between firms is wasteful. Others, including Galbraith [75], Masters [140], Packard [150, 151], and Weiss [232], contend that the emotional content of most advertising is such that it does not lead consumers to intelligent decisions. All of those mentioned above would maintain that there is simply too much advertising -- that it represents a waste of resources.

Some critics of advertising have suggested alternative means of providing consumers with market information. Hollander and Fri [91, p. 5], Stern [192, p. 50], Warne [227, p. 332], and others [9, 77] have suggested that a government administered system of product standards, product grading, and market information dissemination would be more effective and efficient than the present system of providing market information via advertising.

### Hypothetical Sales and Cost Effects of Electric Utility Advertising

Another argument that may be advanced in defense of advertising in general and public utility advertising in particular is that it reduces the costs of products and services to consumers [76, 125, 144, 157, 244]. This line of reasoning is typically based on one or some combination of the two arguments discussed below.

1. Advertising stimulates the demand for electricity and thereby permits utilities to enjoy greater scale economies[1] than would have been possible without advertising [125, 138, 144]. Scale economies in electricity production are based on the fact that larger generating units are more efficient [218, p. 6]. If an overall reduction in unit costs is to be achieved as a result of demand stimulation the reductions in unit production costs, resulting from the use of larger generating

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[1] The existence of scale economies in the production of electric power has been demonstrated empirically by Reynolds [163] and discussed by Garfield [76, p. 17], Troxel [204, p. 29], and Watson [229, p. 203].

equipment, must be greater than the per unit advertising costs needed to achieve the sales gains [125, 144, 243].

2. Advertising permits selective stimulation of demand so as to improve the load factors of utilities [125, 242].[1] The idea is to increase off-peak[2] power sales and spread fixed costs over a larger number of units. The reduction in unit costs, so achieved, would have to be greater than the per unit advertising costs necessary to achieve them if there are to be any possible price reductions to the consumer [233, p. 34].

### General demand stimulation

This argument rests on two assumptions. First, there is the assumption that advertising can stimulate the demand for electricity -- move the demand curve upward and to the right. Second, there is the assumption that there are economies of scale in the production of electric power.

An examination of the first assumption will be one of the major tasks of this study. If it can be shown that advertising stimulates the demand for electricity, the potential for price reductions to consumers still depends on the magnitude of the scale economies associated with the production of electric power. Such economies do exist as Federal Power Commission statistics indicate [218, pp. 27, 28, 67].

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[1] Load factor is defined by the Federal Power Commission as, "...the ratio of the average load over a designated period to the peak load occurring in that period" [220, p. 8].

[2] Off-peak power is power supplied during periods of relatively low system demand [220, p. 7].

However, these economies are not infinite, they become increasingly small as maximum generator size is approached. Companies that are presently using generators of the most efficient size cannot improve their cost situation further by means of general demand stimulation [76, p. 17].

The problem with general demand stimulation is that a utility might achieve such a goal by promoting uses of electricity that add only to peak load [244, p. 24].[1] This sort of increase would require an expansion of generating capacity and would lead to a lower load or utilization factor [244, p. 24]. If the utility had previously been large enough to use equipment of the most efficient size the demand increases described above would bring higher unit production costs due to lower load or utilization factor. If the increase permitted the company to utilize generating equipment of a more efficient size the final effect on unit production costs would depend on two competing effects 1) higher unit costs due to the lower level of plant utilization; 2) lower unit costs due to the larger, more efficient generating equipment.

### Selective stimulation of demand

Kelly [110, p. 385], Welch [233, p. 34], and Wotruba [243, p. 36] have suggested that advertising might be used to stimulate the demand for electricity in a selective fashion. The object of such a strategy would be to improve plant utilization [243, p. 36]. Since a high proportion of an electric utility's expenses are fixed in nature, any improvement in a utility's utilization factor will have a favorable impact on average unit production costs [76, p. 22].

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[1] The Federal Power Commission defines load as "...the amount of electric power delivered at a given point in time" and peak load as "...the maximum load in a stated period of time" [220, p. 10].

The major difference between general and selective approaches to demand stimulation is that in the first case no attention is given to whether the hope for increments in demand will fall on-peak or off-peak. A utility following a selective demand stimulation approach would follow a promptional strategy designed to encourage the off-peak use of electricity [85, 110, 228, 243, 244]. For example, a campaign designed around the "live better electrically" theme would involve general demand stimulation (if any) with increments falling where they may -- some falling on-peak, some falling off-peak. An advertisement based on the theme that outdoor lighting is attractive and discourages burglars is illustrative of an attempt to stimulate demand selectively [110, p. 385]. Increases in sales resulting from this approach will most probably fall off-peak [85].

### Two types of peaks

If the amount of electricity demanded by the customers of a particular electric utility were recorded minute by minute for a given twenty-four hour period a point will be found where demand is greater than at any other point. This point of highest demand is the peak for that day. Since electricity cannot be stored like other commodities, an electric utility must have enough generating capacity to meet, on an instantaneous basis, any level of demand that may occur [76, p. 19].

Figure 2 shows the pattern of electricity use by the customers of Dallas Power and Light for July 11, 1971.[1] Note the relationship between temperature and electricity usage and the fact that peak demand for the day came at 5 p.m. The peak demand on this day was 2,056 megawatts, requiring ninety percent of Dallas Power and Light's 2,288 megawatts of installed generating capacity. According to Garfield and Lovejoy a utility must have enough generating capacity to meet the highest demand for its service, plus "... enough reserve plant capacity in order to assure the continuity of service in the event of a breakdown or some other outage" [76, p. 20]. The Federal Power Commission recommends a minimum reserve at peak equal to fifteen percent of that peak [225, p. I-15-7]. At 5 p.m. on July 11, 1971 Dallas Power and Light had only 232 megawatts or 11 percent of peak in reserve. This means that the company was at effective full capacity at this time. However, for the full twenty-four hour period of this day the capacity factor[2] averaged something less than seventy percent.

The 2,056 megawatts demanded by Dallas Power and Light customers at 5 p.m. on July 11, 1971 was not only the peak for that day, but also the peak for all of 1971 -- the annual peak. The seventy percent capacity factor achieved that day was also the highest for the year. In contrast, the Dallas Power and Light capacity factor for January 1, 1971, the day of lowest demand in 1971, was only twenty-seven percent.

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[1] These data were obtained from Dallas Power and Light Company records.

[2] Capacity factor is defined by the Federal Power Commission as "...the ratio of the average load on a machine or equipment for the period of time considered, to the capacity rating of the machine or equipment" [220, p. 45].

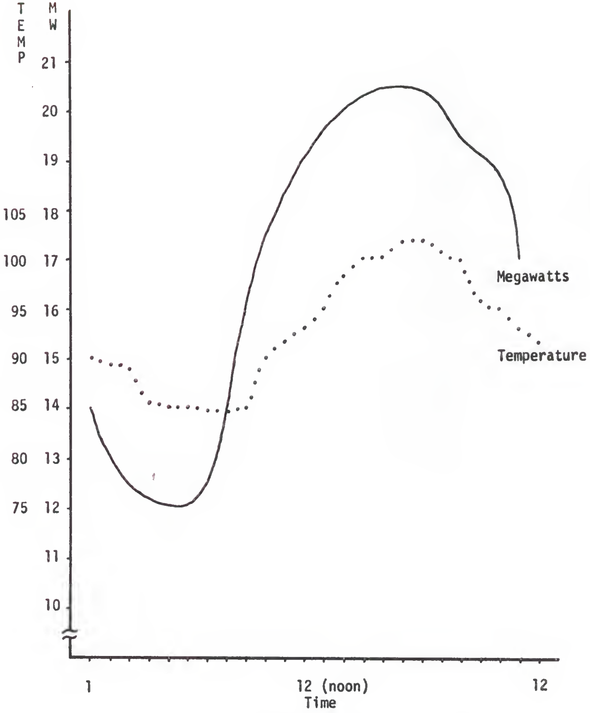

FIGURE 2
MEGAWATTS OF ELECTRICITY DEMANDED BY THE CUSTOMERS OF DALLAS POWER AND LIGHT COMPANY ON JULY 11, 1971

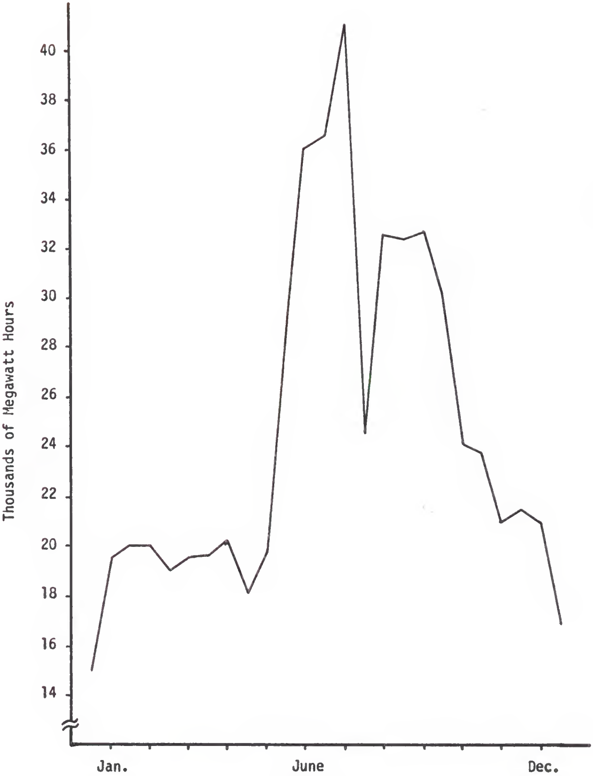

FIGURE 3

DAILY DEMAND FOR ELECTRICITY BY THE CUSTOMERS OF DALLAS POWER AND LIGHT COMPANY FOR 1971 IN MEGAWATT HOURS

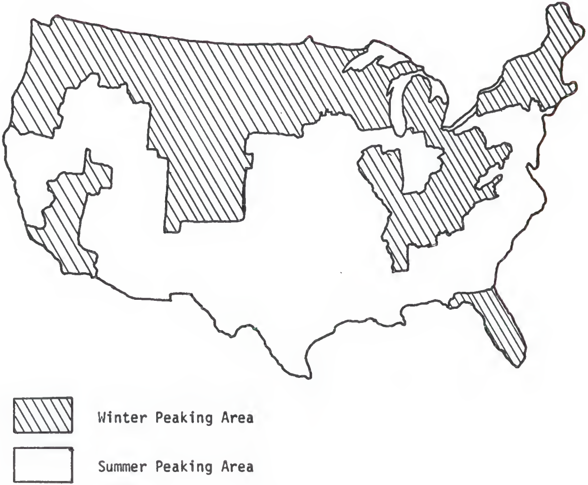

FIGURE 4

SUMMER AND WINTER PEAKING
AREAS OF THE UNITED STATES

Figure 3 shows the pattern of total daily demand for electricity by Dallas Power and Light customers for 1971. Note that the highest daily usage occurred in July and that the warm months are characterized by relatively high demand, while the cool months are characterized by relatively low demand. This indicates the importance of weather in determining the seasonal character of the demand for electricity. This point was made in a recent Federal Power Commission report [225, p. I-18-20]:

> Geographical orientation of electric utility systems and the dominant weather patterns under which they operate are the primary causes of seasonal diversity.

Figure 4 shows the winter and summer peaking areas of the continental United States for 1970. In general, warm areas have August (or summer) peaks and colder areas have December (or winter) peaks.

It has been shown that the residential demand for electricity varies on a daily and a seasonal basis. Since electricity cannot be stored, electric utility systems must have enough productive capacity to satisfy the peak demand for their service on an instantaneous basis. Thus, a considerable amount of an electric utility's productive capacity is idle most of the time [76, p. 20]. If an electric utility is able to motivate people to use more electricity during periods of low demand, it can reduce its average cost of production [242, pp. 42-46].

## Summary

The chapter began with a discussion of the special economic and legal characteristics of electric utilities. These special characteristics include the following: utilities operate as monopolies with government approval, electric utilities supply a service which for many uses has no close substitutes, electric utilities are subject to public regulation of their prices and profits, electric utilities must serve every financially responsible customer in their service area without unjust discrimination, electric utilities have the right of eminent domain.

It was suggested that these unique characteristics of electric utilities stem from the fact that they are natural monopolies. They are called natural monopolies because monopoly is the natural outcome of competition between electric utilities. Monopoly is the natural outcome of competition because electric utilities operate most efficiently as monopolies. Electric utilities operate most efficiently as monopolies because they experience decreasing costs in both the short-run and the long-run. Short-run decreasing costs result from more efficient utilization of fixed facilities. Long-run decreasing costs result from scale economies. Economic efficiency, therefore, dictates that electric utilities operate as monopolies in given market areas.

Economic equity requires that utilities be regulated so that they cannot take advantage of their monopoly power, and to insure that consumers receive the benefit of low cost monopoly production. It was noted that the electric utilities are regulated primarily by means of controls on their prices and profits.

It was argued that electric utilities advertise under special circumstances, and that these special circumstances point to the need for giving their advertising expenditures special scrutiny. The special circumstances under which electric utilities advertise can be divided into two basic categories. First, electric utilities sell a service which for many uses has no close substitutes. Consumers must, therefore, buy a certain amount of advertising with their electricity service whether they desire it or not. This is different than the typical purchase situation where the consumer may seek out nonadvertised brands which may be available at a lower cost than advertised brands. Second, due to the manner in which electric utilities are regulated they are in a position to recapture all of their advertising expenditures from the consumers of electric power whether those consumers desire the advertising or not, and whether those expenditures are effective or not. This is quite different than the situation under which competitive firms advertise. The advertising expenditures of competitive firms can only be recouped if the advertising is effective.

A number of potential functions of electric utility advertising were identified. First, it was noted that it has been argued that advertising represents a form of free speech and that any attempt to control advertising represents a potential infringement on the right of free speech. It was suggested that free speech might not be the real issue, and that no critic could be found who demands a total prohibition of electric utility advertising. It was argued that the main issue appears to be not one of free speech, but a financial one. What appears to be at stake is the right of electric utilities to deduct the cost of advertising in arriving at their allowable earnings. This question is given detailed consideration in the text.

A second possible justification of electric utility advertising is that electric utilities are not pure monopolies in regard to all segments of the home energy market. They compete with natural gas companies and fuel oil dealers for certain segments of the market. These other energy sellers advertise and it can, therefore, be argued that electric utilities have some need to advertise from the standpoint of meeting competition.

Third, it was argued that electric utility advertising provides needed information to the residential users of electricity. The question here is what types of information are truly useful to residential consumers of electricity. There is little doubt that information regarding the proper, safe, and efficient use of electrical appliances is useful to electricity consumers. To the extent that electric utility advertising provides such information, it can be said to be useful.

Fourth, it was suggested that electric utility advertising may enhance the need satisfying ability or the value of electricity service. It was suggested that electric utility advertising might enhance the need satisfying ability of electricity service by reducing the physical and social-psychological risk involved in the consumer's choice of energy type, and by enhancing the image of electricity in the eyes of consumers. It was noted that there are strong arguments against this particular view. These arguments suggest that advertising designed to enhance the images of products or reduce the social-psychological risk involved in consumption decisions too often panders to the frivolous side of human nature.

Finally, it was argued that advertising might successfully reduce the production costs of electric utilities by more than enough to offset the cost of the advertising and thereby bring reductions in total costs. The potential cost reducing effects of electric utility advertising stem from two sources.

First, if demand can be successfully stimulated in the short-run through advertising, costs will be reduced due to improved plant utilization. This is particularly true if demand during off-peak times can be stimulated. Second, cost reductions can be achieved in the long-run if advertising can effect increases in the demand for electricity over time which permit the utility to expand and take advantage of scale economies.

## Findings and Conclusions

Several findings and conclusions are drawn from the analysis presented in this chapter. First, the fact that electric utilities are a special type of business vested with extraordinary powers and subject to extraordinary constraints was established. Second, it would seem that it has also been established that electric utilities advertise under conditions which are markedly different than those under which firms in the competitive sphere advertise.

The most important conclusion of this chapter is that electric utility advertising may serve functions other than those related to sales stimulation. Potentially, the most important of these other functions is the ability of advertising to inform and educate electricity consumers. It is suggested that all the attention which has been directed toward the sales stimulating effects of utility advertising by regulatory commissions, consumer groups, and environmental groups has tended to obscure the fact that advertising might be used as a means to educate consumers in the intelligent use of electricity.

# CHAPTER III

# THE DETERMINANTS OF RESIDENTIAL ELECTRICITY SALES

The main purpose of this chapter is to develop causal links between residential electricity sales and the hypothesized determinants of those sales before proceeding to the empirical analysis of chapters IV and V. These causal links are developed on the basis of marketing and economic theory and on the basis of the findings of previous studies of the determinants of residential electricity sales. The ultimate aim of this chapter is to arrive at a model of the determinants of residential electricity sales that can be evaluated empirically by means of multiple regression.

The chapter begins with a general discussion of the characteristics and applicability of different types of models. On the basis of this discussion it is decided that a symbolic model represents the best approach to testing the hypotheses of this study. Next, the general marketing sales model is considered with a view toward determining its applicability to the electricity sales problem. Finally, the relationship between each of the hypothesized sales determinants and residential electricity sales are considered with a view toward establishing some case for the existence of causal relationships. The selection of multiple regression as the appropriate vehicle to evaluate the performance of the hypothesized model is discussed in Appendix C.

## Models

According to Massy, "a model can be viewed as an hypothesis about the way the world operates. In the most general sense, it is a collection of statements about the way in which certain variables are causally related to one another" [73, p. 56].

Rigby has commented on the value of models as tools of analysis in the following terms [164, p. 109]:

> One of the most effective methods that has been developed for studying relationships within a conceptual scheme is the use of a technique that will in some way represent or depict the relationship and specifically the form which they take. Such a technique is the model, a familiar and well-known tool of science. It has proven extremely helpful in studying and analyzing both ideas and empirical observations.

It would seem that every researcher employs some sort of model to describe or analyze the phenomenon he is investigating. The question is one of determining which type of model is appropriate to a given problem.

Rigby has defined four basic types of models, including: 1) verbal models; 2) iconic models; 3) analog models; and 4) symbolic models [164, pp. 109-112]. A verbal model is one that "...relies on verbal expression to represent the concepts involved and to indicate the form of the regularity" [164, p. 110]. An iconic model "...looks like what it seeks to represent. An example would be a scale model of an airplane built to study a new concept in designing airplanes" [164, p. 109].

The third basic type of model is the analog model. It may, though not necessarily, look like what it represents. It must behave like the phenomenon it represents [235, p. 452]. Examples are charts and graphs used to represent relationships between or among concepts; scale drawings of, say, a parking lot with scale cardboard templates to represent cars; a simulated elipse of the moon using "...a flashlight on a ball and casting a shadow on this ball by passing a second ball between it and the light" [164, p. 110].

The final type of model is the symbolic model. In this type of model "...symbols are used to represent the phenomena being studied" [235, p. 452]. Symbolic models are typically stated in the form of mathematical equations and are often referred to as mathematical models [164, p. 110]. According to Luck et al. symbolic models are "...the most useful types of models for studying marketing problems" [235, p. 41]. This usefulness stems from the fact that "...the symbolic model can be more effectively manipulated than the other types of models" [164, p. 116].

On the basis of the above considerations the decision was made to model the determinants of residential electricity sales in symbolic terms. As a starting point in this process a symbolic representation of the general marketing model is considered in the following section.

## The General Marketing Model

The general marketing model is based on two sets of variables which affect a firm's sales or the demand for its product or service. The first set of variables are referred to as the controllable variables and include those determinants of demand under the firm's control [117, p. 53]. The second set of variables are referred to as the uncontrollable or environmental variables [154]. Included under this heading are those factors which affect the sales or demand for a firm's product but are generally outside the firm's control.

Certainly, this model owes a great deal to economic theory. In 1933 Chamberlain's Theory of Monopolistic Competition was published and the idea of product differentiation was formally introduced into economic analysis. In the following passage Chamberlain explains his concept of product differentiation [45, p. 56]:

> A general class of products is differentiated if any significant basis exists for distinguishing the goods (or services) of one seller from those of another. Such a basis may be real or fancied, so long as it is of any importance whatever to buyers, and leads to a preference for one variety of the product over another. W here such differentiation exists, even though it be slight, buyers will be paired with sellers, not by chance and at random, but according to their preferences.
>
> Differentiation may be based upon certain characteristics of the product itself, such as exclusive patented features; trademarks; trade names; peculiarities of the package or container, if any; or singularity in quality design, color or style. It may also exist with respect to the conditions surrounding its sale. In retail trade, to take only one instance, these conditions include such factors as the convenience of the seller's location, the general tone or character of the establishment, his way of doing business, his reputation for fair dealing, courtesy, efficiency, and all the personal links which attach his customers either to himself or to those employed by him. In so far as these and other intangible factors vary from seller to seller, the "product" in each case is different.

This quote indicates that Chamberlain recognized the importance of product and place policy in the differentiation of a seller's offering from that of his competitors. Chamberlain, of course, recognizes the importance of price policy in determining the demand for the product of an individual seller and later in the book discusses the role of advertising and other promotional outlays in product differentiation [45, p. 117].

Some years later these ideas were picked up by students of marketing, expanded, and integrated into a general model of the firm's marketing behavior. In a now classic article Bordon proposed lists of controllable and uncontrollable variables which determine a firm's sales. Bordon calls the controllable factors the "marketing mix" and the uncontrollable factors the "market forces bearing on the marketing mix" [32, pp. 4, 5]. Bordon's extensive and exhaustive lists of controllable and uncontrollable sales determinants are shown in Tables 2 and 3. Bordon's list, though exhaustive, is a bit unwieldy to work with and includes a number of factors (packaging, physical handling, etc.) which are not relevant to electric utility marketing [85].

Frey has suggested that all elements of the marketing mix (controllable variables) can be classified as either part of the market offering (product, package, brand, price, service) or as one of the methods or tools of marketing (distribution channels, personal selling, etc.) [74, p. 30].

Lazer and Kelly have argued for a trichotomous classification of marketing variables [122, p. 413]. The Lazer and Kelly scheme includes a goods and services mix, a distribution mix, and a communications mix.

In 1964, Jerome McCarthy proposed the now popular "four P's" -- product, price, place, promotion [131, pp. 38-40]. McCarthy calls these the marketing mix or controllable marketing variables. In addition McCarthy proposed a list of environmental factors which individually might or might not be important determinants of a particular firm's sales. McCarthy called these the uncontrollable determinants of sales and included the following list [131, p. 63]:

1. Cultural and social environment
2. Political and legal environment
3. Economic environment
4. Existing business structure
5. Resources and objectives of the firm

McCarthy's model includes the important marketing variables and yet retains the desired simplicity. Kotler has noted that McCarthy's "four P's" are analytically convenient to work with "...because they summarize succinctly the major ways in which the firm can influence sales" [117, p. 55].

Recently Kotler [117, p. 55] and Palda [144, pp. 1-16] have provided more rigorous treatments of this model. Symbolically the basic marketing model becomes:

$$S = (P_1, P_2, P_3, P_4, U_{1-n})$$

where: $S$ = sales
$P_1$ = product policy
$P_2$ = price policy
$P_3$ = place
$P_4$ = promotion
$U_{1-n}$ = some number of environmental or uncontrollable sales determinants

In summary, the foregoing discussion suggests that the sales of a firm's product or service are some function of a number of variables. Some of these variables are directly under the firm's control, while others are completely outside the firm's control. Controllable sales determinants include: specific features of the firm's product or service; place policy or channels of distribution employed in bringing the product or service to consumers; price of the product or service; and the promotional strategy employed to inform, persuade and remind consumers concerning the product or service. Uncontrollable factors include those sales affecting variables which are generally outside the firm's control, including: consumer income; consumer tastes; weather (if product or service sales are weather sensitive in some way); competitors actions; and legal and regulatory constraints. It should be noted that this list is only illustrative of the factors outside the firm's control which may have an effect on the firm's sales.

One of the basic notions of modern marketing is that the firm should try to manipulate those factors under its control so as to achieve its objectives (profits, sales, market share, etc.) and so as to satisfy the needs of the consumers [127, p. 364]. The simultaneous satisfaction of the needs of consumers and the needs of the firm is seen as the key to successful marketing [132]. It has been further suggested by McCarthy [131, 132], Stanton [188], and Lipson and Darling [127] that the firm must adapt to changes in the uncontrollable environment by making changes in those variables under its control.

In Chapter I it was hypothesized that the growth in residential electricity sales can be largely attributed to factors outside the control of individual utility firms. These factors include the rise in consumer income, population growth, population shift to warmer areas of the country, the product innovation and marketing activities of electrical appliance manufacturers, and weather conditions. It was noted that electric utilities have some degree of control over only two potential sales-affecting factors -- electricity price and electricity promotion. The relationship between electricity sales and the hypothesized determinants of those sales are considered in greater detail in the following section.

## TABLE 2

## ELEMENTS OF THE MARKETING MIX OF MANUFACTURERS

1. Product Planning - policies and procedures relating to:
    a. Product lines to be offered - qualities, design, etc.
    b. Markets to sell - whom, where, when, and in what quantity.
    c. New product policy - research and development program.

2. Pricing - policies and procedures relating to:
    a. Price level to adopt.
    b. Specific prices to adopt - odd-even, etc.
    c. Price policy - one-price or varying price, price maintenance, use of list prices, etc.
    d. Margins to adopt - for company, for the trade.

3. Branding - policies and procedures relating to:
    a. Selection of trade marks.
    b. Brand policy - individualized or family brand.
    c. Sale under private label or unbranded.

4. Channels of Distribution - policies and procedures relating to:
    a. Channels to use between plant and consumer.
    b. Degree of selectivity among wholesalers and retailers.
    c. Efforts to gain cooperation of the trade.

5. Personal Selling - policies and procedures relating to:
    a. Burden to be placed on personal selling and the methods to be employed in:
        1. Manufacturer's organization.
        2. Wholesale segment of the trade.
        3. Retail segment of the trade.

6. Advertising - policies and procedures relating to:
    a. Amount to spend - i.e., the burden to be placed on advertising.
    b. Copy platform to adopt:
        1. Product image desired.
        2. Corporate image desired.
    c. Mix of advertising - to the trade, through the trade, to consumers.

7. Promotions - policies and procedures relating to:
    a. Burden to place on special selling plans or devices directed at or through the trade.
    b. Form of these devices for consumer promotions, for trade promotions.

TABLE 2 Continued

8. Packaging - policies and procedures relating to:
    a. Formulation of package and label.
9. Display - policies and procedures relating to:
    a. Burden to be put on display to help effect sale.
    b. Methods to adopt to secure display.
10. Servicing - policies and procedures relating to:
    a. Providing service needed.
11. Physical Handling - policies and procedures relating to:
    a. Warehousing.
    b. Transportation.
    c. Inventories.
12. Fact Finding and Analysis - policies and procedures relating to:
    a. Securing, analysis, and use of facts in marketing operations.

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Source: Bordon [32, p. 4]

## TABLE 3

## MARKET FORCES BEARING ON THE MARKETING MIX

1. Consumers' Buying Behavior - as determined by their:
    - a. Motivation in purchasing.
    - b. Buying habits.
    - c. Living habits.
    - d. Environment (present and future, as revealed by trends, for environment influences consumers' attitudes toward products and their use of them).
    - e. Buying power.
    - f. Number (i.e., how many).

2. The Trade's Behavior - wholesalers' and retailers' behavior, as influenced by:
    - a. Their motivations.
    - b. Their structure, practices, and attitudes.
    - c. Trends in structure and procedures that portend change.

3. Competitors' Position and Behavior - as influenced by:
    - a. Industry structure and the firm's relation thereto.
        1. Size and strength of competitors.
        2. Number of competitors and degree of industry concentration.
        3. Indirect competition - i.e., from other products.
    - b. Relation of supply to demand - oversupply or undersupply.
    - c. Product choices offered consumers by the industry - i.e., quality, price, service.
    - d. Degree to which competitors compete on price vs. non-price bases.
    - e. Competitors' motivations and attitudes - their likely response to the actions of other firms.
    - f. Trends technological and social, portending change in supply and demand.

4. Government Behavior - controls over marketing:
    - a. Regulations over products.
    - b. Regulations over pricing.
    - c. Regulations over competitive practices.
    - d. Regulations over advertising and promotion.

Source: Bordon [32, p. 5]

## Modeling the Determinants of Residential Electricity Sales

In Chapter I it was suggested that residential electricity sales are some function of the following factors: 1) the residential stock of electrical appliances; 2) weather conditions; 3) consumer income; 4) competitive factors including the price and promotional activities of natural gas companies; 5) the price of electricity; 6) and the promotional activities of electric utilities. It was hypothesized that household electricity sales are positively related to appliance stocks, warmth of climate, consumer income, the price of natural gas, and the promotional activities of electric utility firms. It was further hypothesized that residential electricity sales are inversely related to the price of electricity and to the promotional activities of natural gas companies. Data problems which precluded any formal consideration of the effects of natural gas price, promotional activities of natural gas companies, and nonadvertising promotion by electric utilities on residential electricity sales were discussed in Chapter I. In this section causal links between residential electricity sales and the hypothesized sales determinants are explored on theoretical grounds and a model including these sales determinants is specified.

## The Appropriate Measure of Utility Sales

The dependent variable in the general marketing model was specified simply as some measure of sales. It is necessary to be more explicit about the sales measure if any sort of model is to be developed. The selection of a specific form for the dependent variable also influences the forms of the independent variables. Two decisions concerning the appropriate form of the dependent variable were made at this point.

1. First, it was decided to measure sales on a per household basis. This decision was discussed in Chapter I.
2. Second, it was decided to measure sales in physical terms -- in kilowatt hours.

Combining these two decisions leaves kilowatt hour sales per household (or per customer) as the appropriate measure of residential electricity sales.

The rationale for measuring sales in per residential customer terms relates back to the discussion in Chapter I. The typical firm can affect the sales of its product in two ways: 1) increase the number of customers by getting people presently using other brands to use their brand or by getting people presently not using that generic product category to use their brand; or 2) get present customers to use more of the product [33, pp. 111-112].

The electric utility firm does not have this first option. Virtually every household in a utility's service area is an electricity customer. The only way that the utility itself can influence the residential sales of its service is to get its present customers to use more electricity [162]. The number of residential customers served is generally outside of the utility's control. If a family lives within the geographic area served by a particular electric utility that family can buy electricity only from that one electric utility. The number of families moving into and out of that area and the number of new family formations within the area are generally outside the utility's control.

It also makes sense to measure sales in per household terms because the family is the basic consuming unit for electricity. For example, Becker has argued that households are small factories in that "they combine capital goods, raw materials and labor to clean, feed, procreate and otherwise produce useful commodities" [25, p. 43]. Electricity is simply one of the inputs that is purchased by the family for the purpose of producing services for the family. For the above reasons, per household sales of electricity would appear to be the most appropriate measure of electric utility sales for this particular study.

In addition to measuring sales in per household terms it seems appropriate to measure sales in physical terms or in kilowatt hours. This decision was based on the fact that kilowatt hours provide an unchanging and unambiguous unit of measurement as opposed to dollar sales.

## Controllable Variables

A list of variables which may influence a firm's sales and which are under the firm's control was presented earlier. In this section each of these variables will be reviewed from the standpoint of its relevance to electricity marketing.

### Product and Place Policy

Two of the four P's were eliminated from the model of the determinants of electric utility sales. The deleted variables were product policy ($P_1$) and place policy ($P_3$). These variables were deleted not because electric utilities have no policy in these matters but because they have the same policies in regard to these factors [162]. Product policy and place policy are, therefore, not going to help explain why one firm sells more electricity per customer than another or why sales are higher for the industry or a particular firm in one year than in another year. More specifically, product policy ($P_1$) was eliminated because of the lack of product differentiation between individual electric utilities at a given point in time and the lack of product changes in the industry over time.

The argument, again, is not that electric utilities have no product policy but that they all have essentially the same product policy and that this industry-wide policy has not changed significantly over time. All electric utilities sell electricity by the kilowatt hour and a kilowatt hour is a kilowatt hour.[1]

The reasons for eliminating place policy are similar to those advanced for eliminating product policy. All utilities follow essentially the same policy in regard to distribution. All utilities distribute direct to the consumer. This is the way all utilities distribute their service at the present time and this is the way they have always distributed their service [224, p. I-12-2].

The reasons for this pattern of direct distribution are fairly obvious. The only real alternative to this system would be for each home to generate its own electric power on the premises. This is not feasible at this time because of the economies of scale involved in the production of electric power [76, p. 17]. With existing technology, it is cheaper to buy power produced in large plants and transported to the home over fairly long distances by wire than it is to produce power at the home [224, p. I-9-10]. It should be noted that this pattern may change in the future as technology improves. It is possible that fuel cells may be used in the future for the generation of electric power at the home [224, p. I-9-10].[1]

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[1] A kilowatt hour is defined as an amount of electrical energy equivalent to 3412 British thermal units [173, p. 33].

The elimination of product policy ($P_1$) and place policy ($P_3$) leaves the following relationship:

$$S/C = \quad (P_2, P_4, U_{1-n})$$

where: $S/C$ = kilowatt hour sales per residential customer
$C$ = number of residential customers
$P_2$ = price policy
$P_4$ = advertising expenditures

Price Policy

Electric utilities vary considerably in their pricing policies. This fact can be ascertained by reference to the Federal Power Commission's publication Typical Electric Bills [223]. It seems reasonable to hypothesize that price ($P_2$) is an important determinant of electricity sales or demand.

According to Garfield and Lovejoy [76, p. 21], Fisher and Kaysen [72, p. 16], and Wilson [240, p. 9] electricity is like most other commodities in that people will generally buy more of it at low prices than they will at higher prices. There is some empirical evidence which suggests that demand for electricity is relatively inelastic in the short-run [72, 240, 244]. This inelasticity, according to Fisher and Kaysen, can be attributed to the fact that "in the short-run, there is no really important direct substitute for electricity [72, p. 12]. Fisher and Kaysen say that there is no substitute for electricity in the short-run because the consumer cannot easily switch from one fuel to another, even if he wanted to, because of the expensive durable goods involved. Along these very lines Balestra and Nerlove have stated that "...a short-run change in the relative price of gas does not induce many consumers to revise choices once made, because of the high transfer costs involved in the shift to a different type of fuel" [17, p. 586]. In the long-run the demand for electricity becomes relatively price elastic as appliance stocks wear out and are replaced [240, p. 9]. Wilson has summarized the empirical findings regarding the long-run and short-run price elasticity of the residential demand for electricity as follows [240, p. 9]:

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[1] "Fuel cells are electro-chemical devices in which the chemical energy of a fuel, such as hydrogen, is converted directly and continuously to low voltage direct current electricity" [224, p. I-9-9].

> In the short-run, households are more or less locked in or committed to one energy source or another for cooking, water heating, and other household needs because of the fixed costs of durable capital stocks (appliances). Over a sufficiently long period of time, however, the composition of capital stocks can change as old equipment wears out or as new housing units are constructed. In short, theory suggests that the fixed cost associated with the ownership of major appliances is likely to dominate demand conditions in the short-run, where as long-run demand remains elastic, since gas and electricity become substitutable as appliance stocks wear out and are replaced.

### Regulation and utility pricing policy

It should be remembered that electric utilities do not have the freedom of nonregulated firms in the area of pricing. Actually, the control of rates is the principal tool employed to regulate electric utilities. One author has succinctly stated that "...the crux of regulation is the control of rates" [239, p. 542]. Phillips concurs with this point of view in the following quote [155, p. 123]:

> Regulation, as it has developed in the United States, is concerned with rates, service, safety and to a lesser extent, the efficiency of management. In most regulated industries, rate regulation has occupied much of the

> commission's time and has been the subject of continuous controversy.

There are two basic aspects to rate regulation: 1) control of the rate level or earnings; 2) and control of the rate structure or prices [155, p. 123]. In regard to the rate level, electric utilities are permitted to earn a fair rate of return on the fair value of their property [19, p. 520]. This return must be neither so high as to exploit consumers nor so low as to discourage investors [155, p. 123]. In regard to the rate structure, electric utilities are permitted to practice price discrimination for the purpose of expanding the use of their services [76, p. 22].

The fact that electric utilities are permitted to practice price discrimination provides them with some flexibility in their pricing policy. At first, electricity was sold at a uniform price per kilowatt hour to all customers regardless of how much electricity they consumed [155, p. 346].

Today we find that electric utilities are permitted to practice price discrimination on the basis of three considerations, including: 1) type of customer -- residential, commercial, or industrial; 2) quantity of electricity consumed by individual customers within each customer category per year or per month, and; 3) the time at which service is demanded -- peak versus off-peak [76, p. 22]. In general, industrial customers pay a lower average price than commercial customers and commercial customers pay a lower average price than residential customers [155, p. 347]. These differences are based on differences in the average quantity of electricity used by customers in these categories and upon the different price elasticities of demand for electricity exhibited by customers in these different categories [72, p. 119].

Industrial customers use the largest amount of electricity on the average, commercial customers are second (actually classification of a particular customer in one of these categories depends to some extent on his expected power usage), and residential customers are third [155, p. 347]. In general, the price elasticities of demand for electricity exhibited by customers in these different categories follow this same pattern. Industrial customers exhibit the highest price sensitivity (most elastic demand) and residential customers exhibit the least price sensitivity (most inelastic demand) [72, p. 119].

In summary, two points were made in this section. First, it was noted that control of rates is one of the major tools used to regulate the behavior of electric utilities. Second, it was shown that regulatory agencies have not used this tool in a rigid fashion. Regulatory commissions have tended to be most strict in regard to setting the permissable rate of return and in determining the value of the rate base to which this rate of return applies [12]. Regulatory commissions have allowed more discretion to utilities in regard to their rate or pricing schedules [155, pp. 346-356].[1] Specifically, it was noted that utilities are permitted to offer what amount to quantity discounts to promote usage of their service and are permitted to discriminate between customer categories (industrial, commercial, residential) on the basis of their differing price elasticities of demand.

### The appropriate measure of electricity price

The researcher is faced with a problem when attempting to compare the price of electricity to residential customers between firms or over time. First of all, electric utilities price their service in steps so that the consumer's average cost per kilowatt hour continually declines as he uses more electricity [76, p. 135]. This fact suggests that the average price paid by consumers may not be a very meaningful measure of price. Wilson discusses this point as follows: "...a simple average price is insufficient, since it may be endogenous to quantity [240, p. 11].

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[1] Of course, electric utilities are supposed to apply rate schedules which produce the allowable rate of return [76, p. 137].

A second roadblock to arriving at a meaningful measure of electricity price relates to the fact that residential consumers do not pay for electricity a kilowatt hour at a time, they pay for it by the month. It might be suggested that many residential consumers are not aware of the per kilowatt hour price of electricity or the specific rate schedule but are most interested in the size of their monthly bill [17, 240].

It has been suggested that the way to approach this problem is to use the price of some specified volume of electricity [240, p. 11]. In cross-sectional studies the relevant volume of electricity would be the average monthly kilowatt hour usage by residential consumers [17, 72, 240]. Time-series studies present a more difficult problem due to the fact that mean usage by residential consumers may have changed considerably over the period in question. In this case the researcher has several possible measures of quantity to choose from, including: 1) average residential usage over the period; 2) average usage in the first year of the period, and; 3) average usage in the last year of the period. No authority could be found for selecting one of these measures over the others and no rationale can be provided for selecting one measure over the others. This question will be given additional consideration in Chapter IV.

One additional point should be mentioned in this section, the question of relative price. Balestra and Nerlove have suggested that, in addition to reflecting average monthly usage, the appropriate measure of electricity price should reflect the price of substitutes such as natural gas [17, p. 586]. This makes sense in the light of economic theory. The determinants of demand for any commodity include "...the prices of other commodities that might be used in place of the given commodity" [30, p. 263].

There are two ways in which the price of natural gas might have been explicitly included in the model:

1. The price of the average monthly quantity of electricity used per household might have been divided by the price of a comparable amount, in the energy sense, of natural gas to provide a relative price measure.
2. The price of some quantity of gas might have been included in the model as a separate variable.

Unfortunately the lack of data for natural gas utilities precluded any formal consideration of the effects of natural gas price on electricity sales.

### Summary of pricing discussion

In summary, previous studies have shown that the price of electricity is an important determinant of the demand for electricity [72, 240, 244]. It was argued that the residential demand for electricity is relatively price inelastic in the short-run due to the existence of stocks of durable appliances [72, 240]. Over the longer time periods the residential demand for electricity becomes more price elastic as appliance stocks wear out and are replaced [72, 240]. The fact that electric utilities have less discretion in regard to pricing than do nonregulated firms was discussed and arguments against the use of an average price were presented. Finally, the importance of the price of substitutes in determining the demand for electricity was noted.

## Advertising Policies of Electric Utilities

A number of factors will be dealt with in this section. First, the hypothesis that advertising, relative to other determinants of residential electricity sales, has an insignificant effect on residential electricity sales is reconsidered. Next, the observed advertising behavior of the electric utility industry over time and the observed advertising behavior of individual electric utilities in given years is considered. Third, the relative position of advertising in the total promotional mix of electric utilities is considered. Finally, the nature and extent of regulatory control of electric utility advertising is explored.

### Sales effects of electric utility advertising

In Chapter I it was hypothesized that advertising by electric utilities has been a relatively minor factor in the growth of residential electricity sales. This tentative conclusion is based on two considerations. First, utilities spend relatively small amounts on advertising. Industry advertising expenditures are relatively small in absolute amount and relatively small in relation to industry sales revenues. In 1969 the privately owned electric utility industry spent

$173 million on advertising [222, p. XXXVI]. This represents an expenditure of less than $.50 per capita in the areas of the country served by privately owned electric utilities [222, p. XXXII]. The $173 million advertising expenditure amounted to less than 1 percent of the industry's total sales revenues in 1969 [222, p. XXXIII]. In contrast, at least two single industrial corporations spent more on advertising in 1969 than the entire privately owned electric utility industry spent. Proctor and Gamble spent over $275 million and General Motors spent over $214 million on advertising in 1969 [127, p. 729]. In addition, eight other firms spent over $100 million on advertising, individually, in 1969 [127, p. 729].[1] Palda has suggested, in several instances, that when advertising expenditures are small in relation to sales, as is the case of electric utility advertising, that the sales effects of advertising can be expected to be slight [152, 153, 154]. This same point has been made by a number of other researchers [2, 39, 100, 106]. The conclusion is that electric utilities spend such a relatively small amount on advertising that the sales effects of their advertising can not be expected to be large.

The second point, in support of the thesis that advertising by electric utilities has not been a major factor in the growth of residential electricity sales, is that getting people to use more electricity often requires modification of human habit. If utilities are to entice people to use more electricity through advertising, that advertising must be able to persuade people to do many everyday things differently than they are presently doing them. For example, it would be necessary to get people to change their basic menus in order to get them to use more electricity for cooking purposes. Other possible examples include: convincing people to take more showers in order to get them to use more electricity for water heating purposes; convincing people to set their thermostats lower in the summer so that they consume more electricity for air conditioning; convincing people to wash their clothes more often so that they will use more electricity for clothes washing and drying; convincing people to get up earlier in the morning so that they use more electricity in the low usage early morning hours; and so on. The point is that advertising has not been a very effective medium for changing consumer habit.[1] The difficulty of changing human habits through advertising, coupled with the relatively small advertising expenditures of electric utilities are the main reasons for suggesting that the effects of electric utility advertising on residential electricity sales are slight in comparison to sales effects of other hypothesized sales determinants.

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[1] The firms were General Foods, Bristol Myers, Ford Motor, Colgate-Palmolive, Sears, American Home Products, R. J. Reynolds, and Warner-Lambert [127, p. 729].

### Advertising behavior of electric utilities

Electric utilities vary considerably in their relative expenditures on advertising. There has been considerable variation in relative advertising expenditures by the industry over time and there has been considerable variation between the relative advertising expenditures of individual electric utility firms at any given point in time.

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[1] This point has been discussed by Bordon [32], Engel, Kollat, and Blackwell [67, p. 129] and others [29, 116, 117, 132, 166, 199]. See Appendix E for a discussion of theories of how advertising works.

Advertising policies of the electric utility industry and of individual electricity firms vary in at least three measurable ways, including: 1) expenditures per residential customer; 2) media mixes employed; 3) type of advertising used. Tables 7 and 8 in Chapter IV show that there was considerable variation in average per customer advertising expenditures by the industry over the 1951 to 1970 period. Tables M-18 and M-21 in Appendix M show that per customer advertising expenditures by the 61 firms sampled for this study varied from a low of $.27 to a high of $3.16 in 1969.

Unfortunately, there are no data available that show the media mixes and types of advertising employed by individual electric utility firms. Media mix and type of advertising statistics are, however, available for the total industry. A study by the Public Utilities Fortnightly staff shows that in 1964 the average privately owned electric utility spent its advertising budget on different media in the following proportions: 58 percent on newspaper advertising, 24 percent on television advertising, 11 percent on radio advertising, and 7 percent on outdoor advertising [94, p. 64]. This study shows that there has been some change in these proportions over time but that this change has not been significant. In regard to the types of advertising employed by electric utilities, William Kelley has shown that the average straight electric utility spends 33 percent of its budget on institutional advertising, 57 percent on promotional advertising, and 10 percent on appliance advertising [110, p. 393].[1] Kelley's study also shows that the average combination utility spends 18 percent of its advertising budget on institutional advertising, 58 percent on promotional advertising, and 24 percent on appliance advertising [110, p. 393].

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[1] Institutional advertising is advertising whose purpose is the general enhancement of the public image of an individual firm or industry [127, p. 730]. Promotional advertising is advertising whose goal is sales stimulation [127, p. 730]. Appliance advertising is advertising designed to stimulate the sales of particular electrical appliances [110, p. 382].

Advertising policies employed in the industry and by individual electric utility firms also vary in a fourth, not readily measurable, way. Electric utility advertising strategies also vary in terms of creative strategies employed. In other words, certain appeals are more prevalent in industry advertising at certain times, while differences in appeals used in advertising may be found between firms at a given point in time [94, 110]. It is known that two firms may spend equal dollar amounts on advertising per customer and achieve greatly differing sales results due to differences in creative strategies employed [116]. This fact argues against the use of dollar advertising expenditures as a measure of the relative advertising effort expended by different firms. This is definitely a limitation. However, evidence introduced in Chapter I suggested that there has been considerable degree of sameness in the creative strategies employed by electric utility firms in their advertising. Evidence was also introduced to suggest that electric utilities employ roughly the same media mixes and types of advertising.

In summary, electric utility firms can vary their promotional strategies in at least four basic ways, including: expenditures per customer; media mix employed; type of advertising mix employed; and creative appeals used. Data regarding media mixes, types of advertising, and creative appeals are not available for individual electric utility firms. There is, however, some basis for arguing that electric

## TABLE 4

### EXPENDITURES BY PRIVATELY OWNED CLASS A AND B ELECTRIC UTILITIES ON DIFFERENT TYPES OF PROMOTIONAL ACTIVITIES IN 1959 AND 1969

| Promotional Activity | 1969 | | 1959 | |
|---|---|---|---|---|
| | Dollar Expenditure (in Millions) | Percent of Total | Dollar Expenditure (in Millions) | Percent of Total |
| Supervision | 29.2 | 9.5 | 23.9 | 15.3 |
| Demonstration and Selling | 172.9 | 56.7 | 65.8 | 42.1 |
| Advertising | 70.8 | 23.4 | 37.4 | 23.8 |
| Miscellaneous Sales Expenses | 31.6 | 10.4 | 29.5 | 18.8 |
| Total | 304.5 | 100.0 | 156.6 | 100.0 |

Source: Federal Power Commission [222, p. XXXVI] utility firms follow roughly the same policies in regard to these factors. This leaves per customer advertising expenditures as the single observable measure of the advertising strategy of electric utilities. Though this measure has shortcomings, it seems to be a reasonable measure of electric utility advertising strategy for purposes of this study.

### Advertising and the total promotion mix

In Chapter I advertising was defined as "...any form of nonpersonal presentation of ideas, goods or services by an identified sponsor" [8, p. 9]. The primary objective of this study is to determine the relationship between advertising by electric utilities and residential sales of electricity.

It was noted that electric utilities engage in other promotional activities besides advertising. In reports to the Federal Power Commission, electric utilities must break their total promotional expenditures into several major categories, including: 1) supervision; 2) demonstrating and selling expenses; 3) advertising expenses; and 4) miscellaneous sales expenses [226].[1]

Table 4 shows the dollar amounts spent on these different categories of promotional activity by privately owned class A and B electric utilities in 1959 and 1969.

It is interesting to note that total promotional expenditures represented exactly 1.8 percent of class A and B privately owned electric utility operating expenses in both 1959 and 1969 [222, p. XXXVI]. Relative to total promotion expenditures, expenditures on advertising stayed about the same over the period. However, relative expenditures on demonstration and selling increased sharply. Advertising expenditures represented about one-fourth of total promotional expenditures by firms in the industry in both years.

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[1] These different categories of promotion were discussed in Chapter I and are defined in Appendix F.

The above discussion shows that electric utilities engage in a variety of promotional activities and that promotional expenditures that can be identified as advertising related account for about 25 percent of the average electric utility's promotional budget. As stated earlier, this dissertation is primarily concerned with the relationship between electric utility advertising and the residential demand for electricity. Analysis of utility promotion is restricted to advertising for several reasons.[1] First, and most important, is the fact that electric utilities serve several classes of customers. Table 5 shows the percent of customers, percent of kilowatt hour sales, and percent of revenues accounted for by the four major customer types. Residential customers, those of prime interest in this study, account for 88 percent of customers, about 30 percent of kilowatt hour sales, and over 40 percent of revenues. At the other extreme, industrial customers account for .5 percent of total customers, nearly 44 percent of kilowatt hour sales, and a quarter of total revenues.

The point is that one needs to recognize that utilities serve different types of customers and that different types of promotion are used more extensively on certain customer categories. For example, as noted in Chapter I, nearly all of the advertising done by electric utilities is directed toward the residential consumer [94, 110]. This is not the case in regard to demonstration and selling activities [208, 209]. There are no statistics showing what percents of the expenditures on different types of promotion are directed toward the different customer categories. It is known that nearly all advertising is directed to the residential consumer, while demonstration and selling activities are divided more evenly among the different customer categories [94, 110, 208, 209, 221]. Since there is no way to determine the exact proportion of demonstration and selling effort directed toward the residential consumer, advertising expenditures are taken as the best available measure of the intensity of promotional effort at the residential level.

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[1] This point wad discussed in some detail in Chapter I and is repeated here, in summarized form, for the reader's benefit.

TABLE 5

PERCENTAGE OF ELECTRIC CUSTOMERS, SALES, AND REVENUES BY CUSTOMER CLASSES, 1967

| Customer Classification | Percentage of Customers | Percentage of Sales | Percentage of Revenues |
|---|---|---|---|
| Residential | 88.1 | 29.9 | 41.7 |
| Commercial | 11.1 | 21.9 | 28.7 |
| Industrial | .5 | 43.9 | 25.3 |
| Other | .3 | 4.3 | 4.3 |
| Totals | 100.0 | 100.0 | 100.0 |

Source: Edison Electric Institute, Statistical Year Book (1968), [66, pp. 31, 37, 43].

A second reason for restricting the analysis of utility promotion to advertising relates to the diversity of the activities carried out under the heading of demonstration and selling. The list of activities included in the demonstration and selling category, presented in Appendix F, illustrate this point. It is not reasonable to lump all of these different activities together and then try to draw some relationship between their aggregate dollar cost and the residential demand for electric power.

### Utility advertising and utility regulation

When studying the advertising activities of electric utilities one has to remember that utilities do not have the freedom of nonregulated firms in this area. This is not to say that electric utilities have no discretion in regard to advertising, only that their advertising policies are subject to more constraints than are those of the nonregulated firm. For example, Wotruba has made the following comments on this point [242, p. 46]:

> Many nonutility companies spend large sums of money on a variety of sales promotion activities in hopes that at least one of them will pay off. A utility cannot do this, for its expenditures must be justified to the public utilities commission.

It should be made clear that the various regulatory commissions have no power to keep utilities from advertising as much as they would like [155, pp. 187-188]. Regulatory commissions do have the power to decide who will pay for the advertising [157]. Advertising expenses approved by the regulatory commission may be deducted from revenues for purposes of computing return on rate base and are, thus, borne by electricity consumers. Advertising expenses which are not approved by the regulatory commission may not be deducted from revenues for purposes of computing rate of return on rate base and are, thus, borne by the utility's stockholders.

The legal right of public utilities to advertise for the purpose of increasing their sales has been commented on by the supreme court [155, p. 187]:

> A business never stands still. It either grows or decays. Within the limits of reason, advertising or development expenses to foster normal growth are legitimate charges upon income for rate purposes.

The critical phrase in the above passage, in regard to constraints on advertising, is "within the limits of reason." The question is, what criteria do regulatory commissions apply in determining whether a utility's advertising expenditures are within the limits of reason? The answer is that regulatory commissions tend to look at what the particular utility has spent in the past and what other comparable utilities are spending to answer this question [76, p. 53].

The actions of regulatory commissions in individual cases illustrate the philosophy of public policy makers in regard to advertising.

1. The Arkansas Public Utility Commission reduced the allowable advertising expense for Arkansas Power and Light after studying the ratio of advertising expenditures to total operating expenses for a number of comparable utilities. The commission found that Arkansas Power and Light was spending relatively more on advertising than were comparable utilities [157].
2. The Pennsylvania Commission decided [76, p. 53]

   > ...that disputed advertising expenses were not excessive where it appeared that the costs

> involved had increased both the number of customers and the average consumption of services, and where the total expenditure had remained unchanged for fourteen years.

3. Maine's Supreme Court has decided that advertising may be charged to operations when the good faith of management is not in question and it did not appear that such expenses were excessive or unwarranted [157, p. 28].

The preceding discussion indicates that regulatory commissions generally approve advertising as a proper operating expense if it was intended to increase sales and if it is not excessive or extravagant.[1] The question of whether advertising is excessive or extravagant is generally decided by considering a firm's past advertising expenditures and the advertising expenditures of comparable utilities. If these comparisons show that the utility's advertising expenses are in line they are approved. No serious attempts by regulatory commissions to measure the acutal effectiveness of contested utility advertising expenditures could be found.

As a final note, in a 1968 study of utility marketing executives opinions it was concluded that "...a sizable percentage view regulation as hindering marketing effectiveness" [245, p. 32]. One respondent in this study made the following comment [245, p. 32]:

> There is increasing pressure throughout the country to review utility market plans. Should this come about it would definitely hinder effective marketing in competition with the nonregulated energy suppliers.

Thus, those involved in developing utility marketing programs generally view the scrutiny of regulatory agencies as a constraining force.

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[1] For similar conclusions see [76, p. 53] and [157, p. 31].

### Summary of advertising strategy discussion

Four points were discussed in this section. First, it was noted that electric utilities spend relatively small amounts on advertising and that such small expenditures can not reasonably be expected to produce large sales effects. Second, it was noted that the advertising strategies of electric utilities may vary in terms of expenditures per customer, media mixes, type of advertising mix (institutional, promotional, appliance), and creative strategies. There is no way to effectively deal with the latter three factors and there is some reason to assume that these factors are roughly similar for most electric utilities. Per customer advertising expenditures was selected as the best available measure of electric utility advertising strategy.

Third, it was noted that advertising expenditures account for only about a quarter of the average electric utility's promotional budget. However, advertising expenditures were chosen as the best available measure of promotional activity at the residential level because advertising is the only utility promotional activity directed exclusively to the residential consumer.

Finally, the fact that electric utilities are more restricted in their advertising activities than are nonregulated firms was noted.

## Uncontrollable Variables

As noted earlier, a number of factors outside the control of individual utilities are important in determining the demand for electricity.

## Appliance Stocks

The stock of electrical appliances in the hands of consumers was selected as the single most important uncontrollable determinant of residential electricity sales. This decision is based upon the fact that the residential demand for electricity is a derived demand. For example, Fisher and Kaysen have made the following comments on this point [72, p. 10]:

> The demand by households for electricity is a derived demand. In the short run, the community possesses a given stock of each of a variety of electricity -- using appliances and fixtures, which, for simplicity, we shall call "white goods." The demand for electricity for household use is derived from the demand by the community for the services of its various stocks of white goods.

Balestra and Nerlove have made a similar observation in regard to the demand for natural gas [17, p. 585]:

> ...the consumption of gas, at least at the household level, is closely related to the stock of gas appliances in existence and to a large extent gas consumption is governed by such stocks.

The residential demand for gas and for electricity, the two major types of energy used for the production of services in the home, are thus determined largely by the stock of gas appliances and the stock of electric appliances respectively. One would expect the demand for electricity to increase as the stock of appliances increased and to decline as the stock of appliances declined.

Instead of talking about the stock of appliances one should talk about the residential stock of electricity using devices. The latter is more appropriate since it is comprehensive enough to encompass electric heating and air conditioning equipment as well as more traditional electric appliances.

The specific residential electricity using devices to be included in the study and their differing effects on the demand for electricity are considered in Chapters IV and V.

Appliance stocks as a proxy for consumer tastes

Consumer tastes are frequently mentioned by economists as important determinants of demand [30, p. 263]. However, tastes are seldom included explicitly in econometric models because "...no simple measure of tastes exists" [133, p. 88]. One way to handle the problem is to assume that tastes are constant over time, between markets, etc. [133, p. 88]. However, this assumption stretches credibility when demand is being compared between individual markets or when fairly lengthly time periods are involved [154, p. 51].

According to Palda the essence of the economists' approach to the problem of taking tastes into account and predicting their formation in individual market demand analysis can be summed up as follows [154, p. 51]:

> First, tastes are closely tied to some "external" observable and measurable "characteristics" of consumer households, such as the already mentioned categories of age, house ownership and so on. Second, the formation and change of tastes can be predicted by observing these external characteristics in aggregates, in groups. The economist believes that he can describe the mechanism through which changes in nonmonetary factors influence the structure of consumer preferences without investigating the decision-making process that goes on inside the individual consumer.

In this particular study, consumers' tastes or preferences in regard to different types of energy for home use are of prime interest. It is suggested that changes in the stock of electric appliances (including heating and air conditioning) serve as an "...external observable characteristic of consumer households" which reflects changes in consumer tastes in regard to alternative types of energy for home use.

## Consumer Income

It seems reasonable to suggest that the level of consumer income is an important determinant of the residential demand for electricity. A number of authors have suggested that there is a positive relationship between consumer income and the residential demand for electric power [72, 162, 240, 244]. The fact that increases in personal incomes have been one of the major factors behind the great increase in the residential demand for electricity was recognized in the 1970 National Power Survey [224, p. I-3-3]. Disposable personal income, in real terms, increased by 160 percent over the 1950 - 1970 period. Over this same period, per household consumption of electricity increased from 2,000 kilowatt hours per year to over 6,000 kilowatt hours per year [224, p. I-3-3].

It has been suggested that the relationship between consumer incomes and the residential demand for electricity, though positive, is not direct. More specifically, Fisher and Kaysen have argued that a family's long-run income position is an important determinant of its ownership of certain major appliances [72, p. 81]. Fisher and Kaysen have made the following comment on this point [72, p. 5]:

> In general, net changes in the stock of appliances seem mainly to depend on changes in long-run income. The price of electricity seems to have nearly no effect; the prices of appliances only relatively small ones.

John Wilson has also noted the existence of a positive relationship between changes in income and changes in appliance stocks [240, p. 11].

The foregoing discussion supports the hypotheses that there is a positive relationship between consumer income and the household demand for electricity. However, the evidence presented suggests that the link between income and demand is not direct, but is manifested through changes in appliance stocks. This point will be considered in more detail in Chapters IV and V.

### Weather Conditions

The importance of weather in determining the demand for energy has been noted by the Federal Power Commission [224, pp. I-3-1, I-3-6, I-3-12] and others [72, 162, 240, 244]. In particular, the Federal Power Commission has singled out electric heating and air conditioning as "weather-sensitive loads" [224, p. I-3-12]. Wilson has made the following comments regarding the effect of weather on the residential demand for electricity [240, p. 12]:

> ...air conditioning is in greater demand in warm climates, whereas power for heating and clothes drying is subject to greater potential demand in cold climates, and more lighting energy is required where days are shorter and more time is spent indoors.

In regard to home heating, it has been argued that electricity has the advantage over gas in warm areas and that gas has the advantage in cold areas [240, p. 16]:

> ...in cold climates where the cost of home heating is large, operating costs (fuel) dominate consumption decisions, whereas in warm climates where variable costs are much lower, homeowners are more influenced by fixed cost considerations, and there electricity has the advantage.

In summary, a number of researchers have recognized that weather (hot and cold) has an effect on the residential demand for electricity and that air conditioning and heating are the important weather sensitive loads. On the basis of the evidence considered in this section, one should expect to find some relationship between temperature conditions and the residential demand for electricity. One should expect to find a higher per household demand for electricity in warmer areas when other factors are equal.

## Competitor's Actions

It is a well recognized fact that the actions of a firm's competitors may have an effect on its sales [117, pp. 3, 4]. It was noted back in Chapter II that electric utilities have no direct competitors. However, it was also noted that electric utilities do face indirect competition, from other types of energy, for certain residential energy needs -- home heating for example. The fact that competition exists between gas and electric utilities has been recognized by a number of authors [103, 110, 157, 162, 208, 209, 240, 242, 244, 245].

Gas utilities have two weapons to use in their competition with electric utilities, including: 1) price; and 2) advertising expenditures [103]. It, therefore, seems appropriate to include some measure of advertising by gas companies and some measure of gas price in the model. Unfortunately, data problems precluded the formal inclusion of natural gas price in the cross-sectional model. These problems relate to the fact that the areas served by electric utilities are different than the areas served by natural gas utilities and to the fact that price data are not available for natural gas utilities throughout the country.

## Summary

The chapter began with a discussion of the value of models as tools of analysis. Next, the general marketing sales model was discussed. This model specifies that in a general sense the sales of any firm's product are some function of the firm's product policy, price policy, place policy, promotion policy, and a set of factors outside the firm's control. Consumer income, consumer tastes, weather conditions, general economic conditions, the actions of competitors, and legal and regulatory constraints are examples of sales determining or sales affecting factors which are generally outside the firm's direct control. One of the basic notions behind this general marketing sales model is that the firm can manipulate the controllable variables (product, price, place, promotion) so as to affect the sales of its product or service in some desired way. On the other hand, the firm cannot manipulate, at least directly, those sales determinants outside its control. It can only identify and monitor those facets of the external environment which influence its sales. The firm can react to changes in these uncontrollable sales determinants by making changes in the variables under its direct control. For example, the firm might reduce prices in response to price reductions by competitors.

The major part of the chapter was devoted to fitting the special case of electric utility marketing into the general marketing sales model. The first task was to identify those factors which appear to be important determinants of residential electricity sales. In regard to controllable variables, it was suggested that the price and promotion policies pursued by electric utilities have an important effect on their residential sales of electricity. Product and place policy were not included in the model because it was shown that these factors do not play a significant role in the marketing strategies of electric utilities. Four factors outside the direct control of electric utilities were identified as important determinants of residential electricity sales. These factors are the residential stock of electrical appliances and electricity consuming devices, consumer income, weather conditions, and competitor's actions. Competitor's actions are defined to include the prices charged for competitive types of energy and the advertising and other promotional expenditures of firms selling competitive types of energy. Other factors, outside the direct control of electric utilities, which might be important determinants of residential electricity sales were considered but discarded because they were not thought to be important or because data problems precluded any formal consideration of their effects on residential electricity sales. These other factors include the following: the advertising and sales promotion activities of electrical appliance manufacturers, changes in the size of the average home, changes in the quality of home insulation, changes in consumer lifestyles, changes in consumer preferences for different types of energy, and changes in the quality of service offered by electric utilities. It was also recognized that the nonadvertising promotional expenditures of electric utilities are likely to have some positive effect on the residential demand for electricity. However, the impossibility of determining what percent of an electric utility's nonadvertising promotion expenditures are devoted to the stimulation of residential sales and the impossibility of determining how much electric utilities spent on different types of nonadvertising promotion precluded any formal examination of the residential sales effects of nonadvertising promotional expenditures.

In conjunction with the identification of the major determinants of residential electricity sales, evidence was presented to support the contention that each of the items cited above is an important determinant of residential electricity sales. In other words, evidence was presented to establish the reasonableness of the hypotheses regarding the determinants of residential electricity sales presented in Chapter I. A priori reasoning, the findings of empirical studies, tenets of economic theory, and tenets of marketing theory were offered in support of the various hypotheses.

Finally, a general electric utility residential sales model was specified. This model suggests that per customer residential sales of electricity are some function of the price of a specified quantity of electricity, per customer advertising expenditures, the average per customer residential stock of electrical appliances and electricity consuming devices, prevailing temperature conditions in an area, and per household or per capita income. It was suggested that the variation of these five factors will explain most of the variation in per customer residential sales for the industry over time and most of the variation in per customer sales between individual electric utility firms at a given point in time.

The evidence presented in this chapter is in agreement with earlier hypotheses that the per customer stock of electricity consuming devices is the single most important determinant of residential electricity sales. Evidence supports the contention that per customer sales will be higher in areas where the average per customer stock of electrical appliances is higher.

Evidence presented in this chapter also provides justification for considering the residential stock of electrical consuming devices to be largely outside the control of individual electric utility firms. Specifically, it was suggested that the residential stock of electricity consuming devices is largely a function of the prevailing weather conditions, per capita income, and the advertising and sales promotion activities of electrical appliance manufacturers and retailers. Weather conditions determine whether consumers have a need for air conditioning and the strength of that need. Weather conditions also determine whether consumers have a need for home heating, the strength of that need, and whether electric heating is a feasible solution for that need. For example, in very cold areas of the country electric heating is not feasible because of its extremely high operating costs in relation to gas and fuel oil heating. Promotional expenditures of electric utilities may stimulate the demand for both climate controlling devices and other types of electrical appliances. In 1969 the privately owned electric utility industry spent slightly more than 20 million dollars on appliance advertising. In that same year electrical appliance manufacturers and retailers spent somewhere between $800 million and $1 billion on electric appliance advertising. This does not include the amounts that appliance manufacturers and middlemen spent on other types of promotion or the efforts that appliance manufacturers devoted to product innovation and new product development. In conclusion, the advertising expenditures of electric utilities designed to promote the purchase of electric appliances are dwarfed by the advertising expenditures of electrical appliance manufacturers and retailers. For these reasons, the residential stock of electrical appliances is considered to be more outside the control of electric utility firms than it is under their control.

The division of residential electricity sales determinants into a group of factors that are under the direct control of electric utility firms and a group of factors that are outside the direct control of electric utility firms provides some basis upon which to consider the relative sales effects of the two groups of factors. It would appear, based on the evidence presented up to this point, that the uncontrollable factors are much more important in determining per customer residential sales of electricity than are the factors under the firm's direct control. In other words, the per customer stock of electrical appliances, per household or per capita income, and weather conditions have a greater effect on per customer residential electricity sales than do electricity price and per customer advertising expenditures by electric utilities. The implications of this fact, if it should prove to be true, are very significant. It would seem that if residential electricity sales are determined by factors largely outside the control of individual electric utility firms, there is little hope that regulatory bodies can significantly dampen the residential demand for electricity by constraining the activities of electric utility firms. If the major determinants of the residential demand for electricity are outside the control of electric utility firms they are also outside the control of agencies that regulate electric utility firms.

The chapter has provided authority for a list of hypothesized residential sales determinants and a general residential electricity sales model. In the next two chapters multiple regression and other less formalized techniques are used to explore the relationship between residential electricity and the hypothesized sales determinants. The results of time-series analysis of industry sales and sales determinant data are presented in Chapter IV. The results of cross-sectional analysis of sales and sales determinant data for individual electric utility firms are presented in Chapter V. Reasons for using multiple regression as a tool to evaluate the model are presented in Appendixes C, G, and K.

# Chapter IV

# ANALYSIS OF INDUSTRY RESIDENTIAL SALES DATA FOR THE 1951 - 1970 PERIOD

## Introduction

In the previous Chapter, rationale were developed for hypothesizing causal relationships between each of the chosen per customer residential electricity sales determinants and per customer residential electricity sales. In Appendix H, specific data series are selected to represent each of the general sales determinants discussed in Chapter III. These series were selected with a view toward obtaining the best possible measures of the various hypothesized sales determinants. Data employed in the time-series analysis are shown in Tables 7 through 10.

The purposes of this Chapter are twofold. First, changes in various data series, the hypothesized sales determinants and selected measures of industry performance, are scruitinized for the purpose of ascertaining whether there have been underlying changes in the structure of the industry which suggest a greater or lesser need for advertising. In addition, the sales and sales determinant series are analyzed with a view toward discerning basic trends in these factors which have significance for the future.

The second purpose or objective of this Chapter is to attempt to measure, through the use of multiple regression, the degree and magnitude of association between per customer residential electricity sales and each of the hypothesized sales determinants. This analysis is approached with full awareness of the problems associated with the application of regression analysis to time series data. The problems, along with remedies which may be taken to compensate for them, are discussed in Appendix G.

This Chapter is divided into three sections. In the first section, changes in the electric utility industry during the 1951 - 1970 period are discussed. In the second section, movements in the sales and sales determinant series are discussed. In the final section, the sales effects of advertising and the other hypothesized sales determinants are tested by means of multiple regression.

## Changes in the Privately Owned Electric Utility Industry over the 1951 - 1970 Period

A number of measures of supply, demand, performance, and operations for the privately owned electric utility industry are shown in Table 6. Changes in these measures are discussed below.

### The Demand for Electricity

Data in Table 6 show that there were dramatic increases in the demand for electricity over the 1951 - 1970 period.

#### Kilowatt hour sales

Total kilowatt hour sales by the privately owned electric power industry increased by 334 percent over the period in question. Over this same period residential sales grew by nearly 500 percent, significantly outpacing the growth in total electricity sales. Residential electricity sales increased from 21 percent of total electricity sales in 1951 to 29 percent of total electricity sales in 1970, accounting for nearly a

## TABLE 6

## MEASURES OF INDUSTRY SUPPLY, DEMAND, AND PERFORMANCE FOR 1951 AND 1970

| Measures | Years | | Percent Change |
|---|---|---|---|
| | 1951 | 1970 | |
| Total kilowatt hour sales (in billions of kilowatt hours) | 263.2 | 1,142.8 | +334 |
| Total sales revenues (in billions of dollars) | 4.8 | 18.8 | +292 |
| Total residential kilowatt hour sales (in billions of kilowatt hours) | 56.5 | 333.9 | +494 |
| Revenues from residential sales (in billions of dollars) | 1.6 | 7.4 | +362 |
| Number of residential customers (in millions of customers) | 29.5 | 50.2 | + 70 |
| Per customer kilowatt hour sales (in kilowatt hours) | 1,926 | 6,700 | +250 |
| Generating capacity (in millions of kilowatts) | 51.3 | 262.6 | +412 |
| Annual industry capacity factor | 58.5 | 49.6 | - 15 |
| Reserve generating capacity at time of peak (percent of total generating capacity) | 31.0 | 19.0 | - 39 |

Sources: [189, 222]

third of the growth in total sales. Residential demand grew at a faster rate over the period and was a major force behind the growth in the total demand for electricity.

It should also be noted that data in Table 6 indicate that the growth in residential electricity sales can be largely attributed to increases in per customer kilowatt hour sales as opposed to growth in the number of residential customers. Per customer residential consumption of electricity increased by over 250 percent between 1951 and 1970, while the number of residential customers increased by only 70 percent over this period.

In summary, residential electricity sales grew faster than commercial and industrial electricity sales over the past two decades. Residential sales growth has been a major factor in the growth of total electricity sales and has come mainly as a result of increases in per household consumption of electricity. The impact of the above increases in electricity sales on the environment and the nation's natural resource stock are discussed later in this chapter.

### Sales revenues

Sales revenues of the industry increased greatly over the 1951 - 1970 period. Total revenues increased by nearly 300 percent, from $4.8 billion in 1951 to $18.8 billion in 1970. Over this same period revenues from residential sales of electricity increased by 360 percent, from $1.6 billion to $7.4 billion.

It should be noted that sales revenues increased by significantly smaller percentages than did unit sales. This observation holds true for both total sales and residential sales, and indicates that both residential and nonresidential customers paid less per kilowatt hour in

1970 than they had paid in 1951. Electricity consumers paid less in current dollars, and considerably less in real dollars, for every kilowatt hour they purchased in 1970. There is considerable evidence that the decline in electricity prices has reached its low point and that electricity prices will increase significantly over the coming decade. This possibility and the reasons behind it are discussed later in the chapter.

### Electricity Supply

Table 6 shows that in response to a 334 percent increase in the demand for electricity that the industry increased its generating capacity by 412 percent. The fact that the industry increased its generating capacity by a greater amount than industry sales increased might, on initial consideration, lead one to question the concern over electric power shortages. However, further investigation indicates that this concern is warranted for at least two reasons. First, the above statistics are for the entire privately owned electric power industry and do not show that growth in the demand for electricity has outpaced additions to generating capacity in certain areas of the country, the urban centers of the northeastern United States for example [175, 201]. Second the statistics quoted above do not show that there have been fundamental changes in the character of the demand for electricity. These changes can be roughly discerned by reference to two additional statistics: industry capacity factor[1] and reserve generating capacity at the time of peak.[1] In 1951 the privately owned electric utility industry utilized its plants at 58.5 percent of capacity while in 1970 the industry utilized its plants at only 49.6 percent of capacity [222, XXXV]. In 1951 the privately owned electric utility industry had an average margin of reserve at the time of peak load of 31 percent of generating capacity. This figure had declined to 19 percent in 1970. In summary, the average privately owned electric utility utilized its plant less intensively in 1970 than in 1951, but had less reserve capacity at the time of peak demand in 1970 than in 1951.

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[1] Capacity factor is "...the ratio of the average load on a machine or equipment for the period of time considered, to the capacity rating of the machine or equipment" [220, p. 8].

How can the industry simultaneously utilize its plant less efficiently and have less reserve capacity at the time of peak? The answer must be that a disproportionately large amount of the industry's sales gains have been added to peak, as opposed to off-peak, load. In other words, industry sales gains over the 1951 - 1970 period have tended to exaggerate the peaks in the time pattern of demand at the expense of plant utilization.

It might be argued, on the basis of the above discussion, that industry advertising designed to improve plant utilization was ineffective over the 1951 - 1970 period. However, this argument fails to take into account what plant utilization would have been without any advertising. It is impossible to address this question and any attempt to do so would be little more than idle speculation.

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[1] Reserve generating capacity is "...extra generating capacity available to meet unanticipated demands for power or to generate power in the event of loss of generation resulting from scheduled or unscheduled outages of regularly used generating capacity" [220, p. 3].

## Changes in the Electric Utility Industry: Summary and Conclusions

A number of points were made in this section. These points are summarized below.

1. The total unit demand for electricity grew greatly over the 1951-1970 period.
2. The residential demand for electricity grew at a faster rate than did the total demand for electricity over the period in question.
3. Residential sales gains came largely as a result of increasing per customer sales rather than as a result of increases in the number of residential customers.
4. Industry sales revenues grew at a slower rate than did industry unit sales, indicating that the average per unit price of electricity declined over the period.
5. Industry generating capacity grew at a faster rate than did industry sales during the period.
6. Industry plant utilization or capacity factor declined over the two decades.
7. Industry reserve generating capacity declined significantly over the period.

In conclusion, it should be noted that, though electricity demand grew prodigously over the 1951 - 1970 period, the time pattern of electricity demand changed in a way that is very unfavorable to efficient operation. Sales grew in such a way that peak demand was exaggerated in relation to base load. This unbalanced growth simultaneously resulted in a worsening of industry capacity factor and the creation of shortages in generating capacity at the time of peak.

These two factors, the growth in sales and changes in the time pattern of demand would seem to be the major underlying changes in the industry. It would seem that these factors suggest that the primary role of advertising should at the present be the stimulation of off-peak sales. The present relative shortage of electric power indicates that general demand stimulation through advertising is not particularly desirable.

## Changes in Residential Electricity Sales And Residential Electricity Sales Determinant Series Over the 1951 to 1970 Period

### Time Series Data

Data used in the time-series investigation are shown in a series of tables in this section. The five data series chosen (Appendix H) to represent the variables in the model developed in Chapter III are presented in Table 7. It should be noted that the price, income, and per customer advertising data presented in this table have been adjusted for inflation so that they are real values. The same series, unadjusted for inflation, are presented in Table 8. Price indices used to deflate the various series are shown in Table 9. The consumer price index was used to deflate the median family income series, the electricity price index was used to deflate the electricity price series, and the gross national product deflator was used to deflate the per customer advertising expenditure series.[1]

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[1] Reasons for using these different price indices are discussed in Appendix H.

## TABLE 7

## TIME SERIES DATA
(1951-1970)

| Year | Per Customer Kilowatt Hour Sales of Electricity | Price of * 250 Kilowatt Hours of Electricity | Per Customer * Advertising Expenditures | Median * Family Income | Per Customer Appliance Stock Index |
|---|---|---|---|---|---|
| 1951 | 1926 | 7.41 | .68 | 4021 | .116 |
| 1952 | 2085 | 7.44 | .71 | 4180 | .130 |
| 1953 | 2219 | 7.37 | .75 | 4511 | .145 |
| 1954 | 2394 | 7.43 | .79 | 4471 | .157 |
| 1955 | 2559 | 7.35 | .83 | 4738 | .172 |
| 1956 | 2756 | 7.36 | .87 | 4976 | .189 |
| 1957 | 2947 | 7.40 | .87 | 5023 | .199 |
| 1958 | 3091 | 7.36 | .88 | 5054 | .218 |
| 1959 | 3290 | 7.35 | .96 | 5295 | .226 |
| 1960 | 3454 | 7.25 | .99 | 5409 | .243 |
| 1961 | 3661 | 7.26 | .95 | 5497 | .262 |
| 1962 | 3878 | 7.26 | 1.01 | 5614 | .276 |
| 1963 | 4099 | 7.21 | 1.09 | 5822 | .287 |
| 1964 | 4377 | 7.17 | 1.12 | 6026 | .294 |
| 1965 | 4618 | 7.21 | 1.15 | 6268 | .311 |
| 1966 | 4931 | 7.24 | 1.21 | 6539 | .335 |
| 1967 | 5220 | 7.17 | 1.18 | 6746 | .356 |
| 1968 | 5706 | 7.12 | 1.16 | 6978 | .380 |
| 1969 | 6246 | 7.08 | 1.13 | 7184 | .406 |
| 1970 | 6700 | 6.99 | 1.00 | 7125 | .437 |
| Percent Change 1951-70 | +247 | -6 | +47 | +77 | +267 |

*Adjusted for inflation

Sources: [66, 189, 212, 222]

### TABLE 8

### PRICE, INCOME AND ADVERTISING EXPENDITURE DATA UNADJUSTED FOR INFLATION (1951-1970)

| Year | Price of 250 Kilowatt Hours of Electricity | Per Customer Advertising Expenditures | Median Family Income |
|---|---|---|---|
| 1951 | 6.98 | .58 | 3714 |
| 1952 | 7.08 | .62 | 3889 |
| 1953 | 7.10 | .66 | 4233 |
| 1954 | 7.18 | .71 | 4167 |
| 1955 | 7.20 | .75 | 4421 |
| 1956 | 7.23 | .82 | 4787 |
| 1957 | 7.30 | .85 | 4978 |
| 1958 | 7.35 | .88 | 5095 |
| 1959 | 7.45 | .98 | 5417 |
| 1960 | 7.45 | 1.02 | 5620 |
| 1961 | 7.48 | .99 | 5744 |
| 1962 | 7.48 | 1.07 | 5940 |
| 1963 | 7.43 | 1.17 | 6265 |
| 1964 | 7.38 | 1.22 | 6556 |
| 1965 | 7.35 | 1.28 | 6957 |
| 1966 | 7.38 | 1.38 | 7436 |
| 1967 | 7.38 | 1.39 | 8163 |
| 1968 | 7.40 | 1.42 | 8632 |
| 1969 | 7.50 | 1.45 | 9433 |
| 1970 | 7.62 | 1.35 | 9619 |
| Percent Change 1951-70 | +8 | +133 | +159 |

Sources: [66, 212, 222]

## TABLE 9

## PRICE INDICES USED TO DEFLATE THE VARIOUS SERIES (1951-1970)

| Year | Electricity Price Index (1957-59=100) | Consumer Price Index (1957-59=100) | Gross National Product Deflator (1958=100) |
|---|---|---|---|
| 1951 | 94.2 | 90.5 | 85.6 |
| 1952 | 95.1 | 92.5 | 87.5 |
| 1953 | 96.3 | 93.2 | 88.3 |
| 1954 | 96.7 | 93.6 | 89.6 |
| 1955 | 98.0 | 93.3 | 90.9 |
| 1956 | 98.3 | 94.7 | 94.0 |
| 1957 | 98.7 | 98.0 | 97.5 |
| 1958 | 99.9 | 100.7 | 100.0 |
| 1959 | 101.4 | 101.5 | 101.7 |
| 1960 | 102.7 | 103.1 | 103.3 |
| 1961 | 103.0 | 104.2 | 104.6 |
| 1962 | 103.0 | 105.4 | 105.8 |
| 1963 | 103.0 | 106.7 | 107.2 |
| 1964 | 102.5 | 108.1 | 108.9 |
| 1965 | 102.0 | 109.9 | 110.9 |
| 1966 | 102.0 | 113.1 | 113.9 |
| 1967 | 102.9 | 116.3 | 117.6 |
| 1968 | 103.8 | 112.2 | 122.3 |
| 1969 | 105.8 | 127.7 | 128.1 |
| 1970 | 109.3 | 135.3 | 134.9 |
| Percent Change 1951-70 | +16 | +50 | +59 |

Sources: [66, 217]

## The Growth in Electricity Sales

In 1951 the average United States household consumed 1926 kilowatt hours of electricity. This figure had increased by 250 percent to 6700 kilowatt hours in 1970. Over this same period the total residential kilowatt hour sales of privately owned electric utilities increased from 56,530 million kilowatt hours to 333,895 million kilowatt hours, an increase of 494 percent [222, p. XXXIII]. The discrepancy between the gains in per capita residential sales and the gains in total residential sales is due to the fact that total sales reflect both gains in per customer sales and gains in the number of households or residential customers. Total residential sales, number of residential customers, and per residential customer kilowatt hour sales data for the privately owned electric utility industry for 1951 and 1970 were shown in Table 6.

Gains in total unit sales, residential unit sales, per customer unit sales, sales revenues, and number of residential customers were discussed in the previous section. Data are presented in Appendix A which show that increases in electricity sales over the 1951 - 1970 period have been responsible for drastic increases in air pollution, water pollution, and natural resource consumption. It is also suggested that the rapid sales increases of the last 20 years are responsible for the current relative shortages of electric power.

## Public Policy and Electricity Sales Growth: A Comment

The rapid gains in the demand for electricity, the accompanying pollution and power shortages, have prompted action on the part of those charged with the regulation of electric utilities [175, 201]. A number of state commissions have taken action, or are considering taking action, designed to stem the growth in electricity sales, some examples are listed below [175, p. 1]:

1. New York State's Public Service Commission announced it would begin an unprecedented investigation of possible regulations that would cut down the consumption of electricity in New York City. The commission said it might limit the amount of electricity Consolidated Edison can sell for heating and air conditioning or else limit the company to supplying only properly insulated buildings.
2. Some state regulatory commissions are trying to limit the promotional activities of electric power companies. At least three states have requested electric utilities under their jurisdiction to cut back on advertising -- Michigan, New York, and Vermont.
3. The Vermont Commission has recently outlawed, for rate making purposes, all promotional advertising. They are restricting public utilities in their state to advertisements for such things as public events and environmental protection.
4. The Oregon Commission outlawed tie-in deals with builders that encouraged the construction of all electric homes.
5. New York and Michigan regulators distributed new rate increases so that heavy electricity users received higher percentage increases than did light users.
6. The Michigan Commission recently ordered Detroit Edison Company to make its stockholders and not its customers pay

for some advertisements explaining why the company applied for higher rates.

7. Some utilities have acted on their own to reduce promotional expenditures. The Allegheny Power System decided in May of 1972 to discontinue all advertising designed to increase sales. Consolidated Edison is voluntarily devoting a portion of its advertising budget to a campaign providing suggestions to consumers on how to conserve power.

The above are just some of the recent actions taken by regulatory commissions with a view toward discouraging the consumption of electric power.

The surprisingly small amount of empirical research on the determinants of the demand and the complete lack of empirical research on the effectiveness of electric utility advertising were noted earlier. One must then wonder on what rationale the above regulatory commission actions were based.

The commission actions listed above indicate several things about the thinking of utility regulatory bodies. First, it seems that most of the actions have been directed at the residential segment of the market. Second, the commissions appear to at least implicitly assume that advertising and other promotional activities have a significant positive impact on the demand for electricity. There also seems to be some feeling among regulators that the only effects of advertising are sales effects.

In regard to the first point, it must be remembered that the residential demand for electricity makes up only about 25 percent of the total demand for electricity [224, p. I-1-13]. This means, as noted by the Federal Power Commission, that "...it would take a 10 percent reduction in today's household consumption to achieve a 2.5 percent reduction in today's total consumption [of electricity]" [224, I-1-13]. It would therefore seem that if regulatory commissions are to achieve their goal of a reduction in the rate of increase in the demand for electric power that they must also recognize the commercial and industrial segments of the total market for electricity.

The regulators' implicit assumption that advertising is a significant determinant of the demand for electricity, as noted earlier, lacks empirical support. It should be noted that this view also fails to recognize that advertising may be used for other purposes, informing consumers how to use their appliances more intelligently for example, than selling more of the service. The various goals which might be accomplished by electric utilities through advertising were discussed in Chapter II.

It would seem, on the basis of the above discussion that utility regulatory commissions would be in a better position to influence the demand for electricity if they had a better idea of what factors determine the demand for electricity. Providing a better idea of what factors influence the residential demand for electricity is a major objective of this dissertation.

## Advertising Expenditures

Per customer advertising expenditures by the privately owned electric utility industry (Table 7) increased by 47 percent in real terms between 1951 and 1970. However, this statistic is somewhat deceptive. Expenditures gradually increased from 1951 through 1966 and have gradually decreased since then. Per customer advertising expenditures in 1966 were 78 percent greater than per customer expenditures in 1951, while 1970 per customer advertising expenditures were nearly 20 percent less than 1966 per customer advertising expenditures.

The main reason for this decline in advertising expenditures per customer appears to be increased scrutiny by regulatory agencies [157, 201]. In turn, regulatory agencies have become increasingly suspicious of sales stimulating activities, like advertising, in the face of power shortages, pressure from consumer groups, and pressure from environmentalists [157, 175, 201].

## Advertising and Kilowatt Hour Sales

Comparison of the changes in advertising expenditures with the changes in kilowatt hour sales (Table 7) provides some interesting contrasts. First, per customer sales increased by nearly 250 percent while advertising expenditures increased by only 47 percent over the 1951 - 1970 period. Second, per customer advertising expenditures were decreased by nearly 20 percent between 1966 and 1970. Over this same four year period, per customer sales increased by nearly 37 percent, from 4931 kilowatt hours in 1966 to 6700 kilowatt hours in 1970. In summary, both the per customer sales and per customer advertising expenditures series consistently increased between 1951 and 1966. Per customer sales, however, increased at a much faster rate over this period. Per customer advertising expenditures began to decline in 1966 and continued to decline through 1970. Over this same period per customer sales continued to grow at about the same rate evidenced between 1951 and 1966.

## TABLE 10

## PER CUSTOMER OWNERSHIP OF THE FOUR LARGEST POWER CONSUMING ELECTRICAL APPLIANCES (1951-1970)

| Year | Electric Ranges | Electric Water Heaters | Electric Home Freezers | Room Air Conditioners |
|---|---|---|---|---|
| 1951 | .227 | .127 | .093 | .008 |
| 1952 | .241 | .137 | .115 | .014 |
| 1953 | .259 | .147 | .134 | .026 |
| 1954 | .270 | .152 | .151 | .040 |
| 1955 | .280 | .163 | .168 | .056 |
| 1956 | .308 | .170 | .180 | .076 |
| 1957 | .312 | .171 | .192 | .096 |
| 1958 | .338 | .182 | .210 | .117 |
| 1959 | .339 | .186 | .221 | .128 |
| 1960 | .373 | .189 | .234 | .151 |
| 1961 | .385 | .207 | .247 | .170 |
| 1962 | .390 | .218 | .256 | .188 |
| 1963 | .401 | .229 | .264 | .194 |
| 1964 | .414 | .232 | .267 | .202 |
| 1965 | .424 | .234 | .272 | .242 |
| 1966 | .446 | .247 | .275 | .279 |
| 1967 | .470 | .261 | .277 | .307 |
| 1968 | .499 | .278 | .285 | .335 |
| 1969 | .527 | .296 | .296 | .367 |
| 1970 | .555 | .316 | .312 | .406 |
| Percent Change 1951-70 | +144 | +149 | +236 | +5000 |

Source: Statistical and Marketing Report [189].

An examination of the percentage increases for the different series, shown in Table 7, indicates that changes in the appliance stock series closely parallel changes in the per customer sales series. This relationship adds some credence to the earlier prediction that the per customer stock of appliances is the most important determinant of per customer electricity sales. The demand for electricity is a derived demand, it is largely dependent upon the stock of electricity consuming appliances [17, 72]. The per customer stock of electricity consuming appliances increased by nearly 300 percent over the 1951 - 1970 period.

At this point it would appear that changes in the per customer stock of electrical appliances are associated more closely with changes in per customer appliance stocks than with changes in any of the other hypothesized sales determinants. The data in Table 7 also tend to indicate that changes in the per customer stock of appliances are more closely related to changes in per customer income than to changes in per customer advertising expenditures or changes in the price of 250 kilowatt hours.

The above discussion suggests that the per customer stock of electrical appliances is the major determinant of per customer residential sales of electricity. This discussion also shows that there is little relationship between the per customer stock of appliances and per customer advertising by electric utilities. One might expect that there is a more direct link between appliance sales and advertising by appliance manufacturers than between appliance sales and the advertising expenditures of electric utilities.[1] It was noted in Chapter I, that the lack reliable data on advertising by electrical appliance manufacturers and retailers precluded any formal consideration of its sales effects. A rough estimate indicates that in 1970 electrical appliance manufacturers spent something over $400 million advertising their wares and that electrical appliance retailers spent a like amount on electrical appliance advertising.[1] The estimated $800 million spent on electrical appliance advertising by electrical appliance manufacturers and retailers is over 40 times the $20 million spent by the electric utility on appliance advertising.

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[1] As noted earlier, less than 12 percent of all electric utility advertising or about $20 million was directed toward appliance sales in 1969 [110, p. 393].

Changes in Median Family Income

The data in Table 7 show that, between 1951 and 1970, median family income increased by over 77 percent in real terms. Although large, this increase is considerably less than the increases in per customer kilowatt hour sales or in the per customer stock of electricity consuming appliances.

Consumer income is one of those factors completely outside the control of electric utilities which has a significant effect on the demand for their product [224, I-3-3]. The level of consumer income will take its own course largely outside the influence of electric utilities. It is suggested that income affects the demand for electricity because it affects the demand for appliances.

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[1] The estimate of advertising expenditures by electrical appliance manufacturers was obtained by multiplying total 1970 electrical appliance sales of $11.5 billion by 3.5 percent. Industry sales were obtained from the Statistical Abstract of the United States [213, p. 718]. The 3.5 percent represents the estimated proportion of sales devoted to advertising by electrical appliance manufacturers [48, 106].

## Changes in the Price of 250 Kilowatt Hours

The price of electricity has increased much more slowly than the prices of consumer goods in general. Table 8 shows that the price of 250 kilowatts of electricity increased gradually from 1951 to 1962. The price increased from \$6.98 in 1951 to \$7.48 in 1962, an increase of slightly more than 7 percent. Over this same period the Consumer Price Index (Table 9) increased by more than 16 percent. From 1962 through 1965 the price of 250 kilowatt hours of electricity declined by nearly 2 percent. The consumer price index increased by nearly 5 percent over this same period. In 1966 the price of 250 kilowatts of electricity began to increase again. This increase continued through 1970 and amounted to 3 percent for the period (1966-1970). During this same period the consumer price index increased by 20 percent. Over the entire 20 year period (1951-1970) the price of 250 kilowatt hours of electricity increased by less than 10 percent while consumer prices in general increased by over 50 percent.

The reasons for the slow rise in electricity price, relative to the prices of consumer goods in general, are summarized in the following passage [224, p. I-1-34]:

> The electric power industry's remarkable price record, achieved in the face of rising costs of labor and materials and general inflation, was made possible by gains in efficiency and economies of scale. Through technological progress the industry was able to build progressively larger, more efficient installations in which, despite the adverse cost factors just mentioned, the investment required per kilowatt hour of electrical output was steadily reduced. In effect, the power industry was capitalizing on its capital-intensive nature -- i.e., on the fact that a high proportion of the cost of producing and supplying electricity is made up of the fixed charges on the plant investment.

The Federal Power Commission predicts that the actual dollar price of 250 kilowatt hours of electricity may more than double between 1968 and 1990 [224, p. I-1-34]. The reasons for this expected increase are summarized below [224, p. I-1-34]:

> Prominent among the influences causing this marked change in the historical [price] trend are: added cost for environmental protection and enhancement features; sharply increasing competition for available fossil fuels; rising fixed charges for the increasingly capital intensive industry -- all of which are unlikely to be fully offset by the gains expected from economies of scale and new technology.

In summary, over the 1951-70 period the electric power industry was able to more than offset rising fuel and labor costs through improvements in technology and scale economies. However, the Federal Power Commission estimates that the 1970-1990 period will be characterized by rising electricity prices. Over this period technological gains will no longer be sufficient to offset the rising costs of the inputs required by the industry.

## Changes in Sales and Sales Determinants: Summary

A number of observations were made in this section. The observations are summarized below:

1. Per customer residential sales of electricity grew prodigiously over the 1951 - 1970 period.
2. The rapid growth in per customer sales has been a significant factor in the growth of air pollution, water pollution, and natural resource consumption by the electric power industry. The growth in per customer consumption of electricity has also contributed to the development of power shortages.

3. Public policy makers in some areas of the country have begun to discourage advertising by electric utilities. It would appear that these public policy makers at least implicitly assume that advertising has been a major force in the growth of electric utility sales. This assumption lacks empirical support.
4. Simple comparison of the per customer sales and per customer advertising expenditures series indicate that there is little association between the two variables. Sales increased much more sharply than advertising expenditures over the period. In addition, sales continued to increase in the latter part of the period while advertising expenditures were decreasing.
5. Simple comparisons indicate that changes in the per customer stock of electrical appliances parallel changes in per customer sales very closely.
6. Median family income increased considerably over the period. However, income increased by a much smaller percentage than did per customer sales. It would seem that income affects sales indirectly through its effect on appliance ownership.
7. The price of 250 kilowatts of electricity declined slightly in real terms over the period. However, simple comparison of the sales and price series do not provide a clear picture of possible association between the two series.

In conclusion, simple comparisons of variation in the various series indicate that per customer sales are most directly responsive to changes in the per customer stock of electrical appliances as hypothesized earlier. In the following section the relationships between per customer sales and the various determinants of per customer sales are evaluated by means of simple correlation and multiple regression.

## Analysis of Time-Series Data By Means Of Simple Correlation and Multiple Regression

In this section the model presented at the end of Chapter III is tested by means of simple correlation and multiple regressions using the time-series data presented in Table 7 in the first part of this Chapter. The model presented in Chapter III is shown below:

$$S/C = a + B_1P_2 + B_2P_4 + B_3A_x + B_4Y + u$$

where: $S/C$ = kilowatt hour sales per residential customer

$a$ = constant term

$B_{1-4}$ = regression coefficients associated with respective independent variables

$P_2$ = price of 250 kilowatt hours adjusted for inflation

$P_4$ = advertising expenditures per customer adjusted for inflation

$A_x$ = per customer (residential) appliance stock index

$Y$ = median family income adjusted for inflation

$u$ = unknown random error term

### Simple Correlations

The simple correlations between sales and the hypothesized sales determinants are shown in Table 11.

A glance at the first column in Table 11 shows that all the independent variables are highly correlated with per customer sales

(S/C). The mathematical signs of all the coefficients appear to be appropriate. The signs of the correlation coefficients indicate that the relationships between per customer sales (S/C) and per customer advertising expenditures ($P_4$), per customer sales and median family income (Y), and per customer sales (S/C) and per customer stock of appliances ($A_x$) are all positive. These results indicate that per customer sales tend to increase as per customer advertising, median family income, or the per customer stock of appliances increase. The relationship between per customer sales (S/C) and the price of 250 kilowatts ($P_2$) is negative, indicating that as price increases sales decrease. All of the above relationships make sense and are in line with hypotheses stated earlier.

TABLE 11

SIMPLE CORRELATIONS
PER CUSTOMER SALES AND
SALES DETERMINANTS
(1951-1970)

| Variables | S/C | $P_2$ | $P_4$ | Y | $A_x$ |
|---|---|---|---|---|---|
| S/C | 1.00 | | | | |
| $P_2$ | - .96 | 1.00 | | | |
| $P_4$ | .84 | - .79 | 1.00 | | |
| Y | .98 | - .94 | .91 | 1.00 | |
| $A_x$ | .99 | - .96 | .87 | .99 | 1.00 |

The high correlations between the variable pairs indicate that considerable collinearity exists between the various data series [102, p. 163]. The relatively high correlation between per customer sales (S/C) and per customer advertising ($P_4$) is of particular interest in this investigation. Squaring this simple correlation coefficient provides a coefficient of multiple determination of .71 indicating that the variation in advertising expenditures explain 71 percent of the variation in per customer sales. It would be hasty to assume that this is a true characterization of the nature of the advertising-sales relationship. Baumol has discussed the difficulties encountered in time-series analyses of advertising-sales relationships, as follows [22, p. 222]:

> Now while sales are doubtless affected by advertising, as the advertising-demand function assumes, this function is often accompanied by a second relationship in which what we might call the direction of causation is reversed. It is well known that a firm's advertising budget is frequently affected by its sales volume. In fact, many businesses operate on a rule of thumb which allocates to advertising expenditure a fixed proportion of their total revenues.

This problem has been avoided to some extent in this analysis by using unit sales rather than dollar sales as the dependent variable. However, since one can usually expect to find a high degree of correlation between dollar sales and unit sales, the problem is not avoided entirely. With these thoughts in mind, the multiple regression results will be considered.

## Multiple Regression Results

The multiple regression results are shown in Table 12. The high points of these results are summarized below.

## TABLE 12

## RESULTS OF TIME SERIES MULTIPLE REGRESSION

| Statistics | | Calculated Values |
|---|---|---|
| a | (Constant) | 2655.60 |
| $B_1$ | (Price Regression Coefficient) | - 524.27 |
| $B_2$ | (Advertising Regression Coefficient) | -1687.42* |
| $B_3$ | (Income Regression Coefficient) | .79* |
| $B_4$ | (Appliance Regression Coefficient) | 8636.23* |
| $R^2$ | (Coefficient of Multiple Determination) | .998** |
| D | (Durbin-Watson) | 1.385*** |

*Significant at .01 level (t test)
**Significant at .01 level (F test)
***In the range of indeterminacy, cannot accept or reject the hypothesis of zero autocorrelation at the .01 level.

1. The coefficient of multiple determination ($R^2$) indicates that the variation of the independent variables in the model explain 99.8 percent of the variation in the dependent variable.
2. The calculated regression coefficients indicate the following:
   a. Each one dollar increase in the price of 250 kilowatt hours will decrease per customer sales by 524.27 kilowatt hours.[1]

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[1] It is not suggested that the fact the regression coefficient associated with price is 524.27 proves that a causal relationship

b. Each one dollar increase in advertising expenditures per customer will decrease per customer sales by 1687 kilowatt hours.

c. Each one dollar increase in median family income will increase per customer sales by .79 kilowatt hours.

d. Each one unit increase in the per customer appliance stock index will increase per customer sales by 1836 kilowatt hours. It should be noted, as pointed out earlier, that the per customer appliance stock index can only vary between zero and unity. A .1 increase in the index will increase per customer sales by 863 kilowatt hours and a .01 increase in the index will increase per customer sales by 86 kilowatt hours.

e. All of the regression coefficients are significantly different from zero at .01 level with the exception of the coefficient associated with the price of 250 kilowatt hours.

3. The computed Durbin-Watson statistic is in the range of indeterminancy. The hypothesis of zero autocorrelation cannot be accepted or rejected.

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exists between sales and price or that a one dollar increase in price will in fact decrease sales by 524.27 kilowatt hours. The statement is simply an explicit interpretation of the calculated value of the regression coefficient. Whether or not the calculated value is reasonable and whether or not a causal relationship exists are other matters. These questions can only be answered by considering all the evidence. This statement applies to all the discussions of correlation and regression results which follow.

Comments on the multiple regression results

The model produced a very high coefficient of determination. However, it suffers from at least one obvious weakness -- the sign of the regression coefficient associated with per customer advertising is negative. This implies that per customer sales decrease as per customer advertising expenditures increase. This finding not only flys in the face of what one would reasonably expect but also runs contrary to the simple correlation results shown in Table 11. The simple correlation results show that a positive relationship exists between sales and advertising expenditures. The fact that the advertising-sales relationship was positive in the simple correlation analysis but negative in the multiple regression analysis can only be due to multicollinearity [10, p. 160].

The simple correlation analysis (Table 11) shows that the independent variables are highly collinear or are heavily correlated with one another. It is noted in appendix that this condition makes it very difficult, perhaps impossible, to "...disentangle the relative influences of the various dependent variables" [10, p. 160]. The fact that considerable multicollinearity exists in the data series not only explains the negative sign of the regression coefficient associated with per customer advertising expenditures but also leaves the values of the other regression coefficients open to suspicion [240, p. 10]. As indicated earlier, the test for autocorrelation was inconclusive. The data series employed in the model may or may not be autocorrelated.

The certain existence of multicollinearity between the data series and the possible existence of autocorrelation in the data series makes the interpretation of the individual regression coefficients extremely hazardous [107, pp. 354, 362].

In summary, applying the multiple regression model derived in Chapter III to aggregate time-series data for the privately owned electric utility industry has provided results which, primarily in regard to the effects of advertising on sales, are not very realistic. Though this analysis showed that advertising has a considerable negative effect on sales, no confidence can be placed in this finding because of the certain existence of multicollinearity and the possible existence of autocorrelation in the data series. These two problems also reduce greatly the confidence that can be placed in the estimated effects of the other independent variables. It should be noted that, although the model proved to have limited explanatory power, it does have good predictive power.

## Summary and Conclusions

Two objectives were persued in this Chapter. First, the per customer sales series, sales determinant series, and selected measures of industry performance were scrutinized for the purpose of discerning basic trends and changes in the structure of the industry. This analysis was performed in the first two content sections of the report. It was noted that total electricity sales more than quadrupled over the 1951 - 1970 period, and that residential sales grew at a faster rate than total electricity sales over this period. In turn, it was shown that increases in residential sales can be largely attributed to increases in per household usage. It was also noted that total electricity sales grew at the expense of efficient plant utilization in that a disproportionately high percentage of the industry's sales gains came as additions to peak as opposed to off-peak loads. This development has brought shrinking margins of reserve generating capacity and is responsible for the current relative shortages of electric power which exist in certain parts of the country.

Simple comparisons between changes in per household sales of electricity and the hypothesized determinants of these sales tend to indicate that changes in per household electricity sales are most closely associated with changes in the per household stock of electrical appliances. Comparison of the per customer sales and per customer advertising series provided little indication that the two variables are associated in any significant way. In fact it was observed that while per customer advertising decreased between 1966 and 1970 per customer sales continued to increase at about the same rate evidenced between 1951 and 1965.

It was noted that though there does not appear to be a close relationship between per customer sales and per customer advertising by electric utilities there may be a significant relationship between per household electricity sales and the advertising and product innovation activities of electrical appliance manufacturers. In 1970 electrical appliance manufacturers and retailers spent about 40 times more on appliance advertising than the electric utility industry spent. Advertising expenditures of this magnitude are likely to have an effect on the sales of various electrical appliances and thus on per household sales of electricity. As noted earlier, the unreliability of the estimates of advertising expenditures by electrical appliance retailers and manufacturers made it unrealistic to include this variable in the model in any formal way.

Finally, in regard to the first objective, simple comparison of the changes in median family income and the price of 250 kilowatt hours with changes in per customer kilowatt hour demand over the period indicate the existence of a fairly high level of association between each of these variables and per customer demand.

The second purpose of this chapter was to attempt to measure, through the use of multiple regression, the degree and magnitude of association between per customer residential electricity sales and each of the hypothesized sales determinants. This analysis provided further evidence in support of the contention that the per customer stock of electrical appliances is the most important single determinant of the per customer residential demand for electricity. This analysis also indicated the following: the price of 250 kilowatt hours is inversely related to per customer sales, median family income is positively related to sales, per customer advertising expenditures are positively related to sales.[1]

Several observations can be made on the basis of the data and analysis presented in this chapter. First, data presented early in the chapter indicated that the demand for electricity grew prodigiously over the 1951 - 1970 period. This growth in demand has had several adverse effects. First, it has been the source of considerable air and water pollution. Second, it has been responsible for a significant depletion in the nation's fossil fuel (coal, oil, natural gas) resources.[1] Finally, in certain parts of the country, the tremendous increases in the demand for electricity have nearly outrun the industry's ability to supply electricity.

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[1] Per customer advertising expenditures were shown to be positively related to sales in the correlation analysis and inversely related to sales in the multiple regression analysis. This apparent contradiction points to the pitfalls involved in applying multiple regression analysis to time-series data. The conclusion must be that industry per customer sales and industry per customer advertising expenditures are positively associated over time and that the inverse relationship between the two variables encountered in the multiple regression analysis is due to multicollinearity.

The above mentioned developments have, of course, attracted the attention of those public policy makers charged with the responsibility of regulating privately owned electric utilities. These regulators have increasingly concerned themselves with ways in which they might stem the tide of continuing increases in the demand for electricity. Evidence presented in this chapter indicates that regulatory commission actions designed to dampen increases in the residential demand for electricity have centered around restriction of the advertising activities of electric utilities.

The analysis presented in this chapter indicates that the restriction of electric utility advertising activities is not likely to have a significant effect on the residential demand for electricity. Per customer advertising by electric utilities and per customer sales by electric utilities do not appear to be associated in any significant way.[2] There is no empirical evidence to suggest that reductions in per customer advertising expenditures by the industry will have a significant dampening effect on the residential demand for electricity. The empirical evidence presented in this chapter tends to support the thesis that advertising by electric utilities does not have a significant or measureable effect on the residential demand for electricity. This conslusion is supported by the statistical analysis presented in this chapter and, perhaps more importantly, by the fact that per customer residential sales continued to increase at a unabated rate between 1966 and 1970, while over this same period average per customer advertising expenditures by the industry declined significantly. If utility advertising has no measurable effect on the household demand for electricity it follows that such advertising cannot bring production cost reductions bassed on scale economies or better plant utilization. However, before advertising by electric utilities is dismissed as wasteful it should be remembered that advertising may serve other functions besides sales stimulation. These other potential functions were discussed in Chapter II and include the following: 1) advertising is a necessary competitive tool; 2) advertising can supply product and product use information; 3) advertising may augment the need satisfying power of the service. In view of the current shortages of electric power it seems that the second function mentioned above should be of particular interest. Instead of eliminating advertising by electric utilities perhaps what is needed is a reorientation of industry advertising objectives. Perhaps it would be more appropriate for electric utilities to devote most of their advertising effort toward educating people in the more efficient use of electricity rather than simply trying to encourage them to continue to consume increasing amounts of electricity.[1]

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[1] See Appendix A for a discussion of the pollution and natural resource consumption problems associated with electric power production.

[2] No significant relationship was found when current per customer advertising expenditures were regressed against current per customer sales or when current per customer sales were regressed against lagged and cumulative per customer advertising expenditures. The lagged and cumulative effects of electric utility advertising are discussed in Appendix I.

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[1] This point is duscussed in greater detail in Chapter VI.

The analysis presented in this chapter tends to support the thesis that the major force behind the rapid growth in the residential demand for electricity has been and will continue to be the increasing stock of electrical appliances found in the average home. This fact is illustrated dramatically by the increasing ownership of room air conditioners. In 1951 less than 1 percent of all homes in this country had room air conditioners. Over 40 percent of all homes had room air conditioners in 1970.[1] The growth of electrical appliance ownership and use appears to be related to two major factors. First, there is the general and significant rise in the average standard of living experienced over the 1951 - 1970 period. This rise in the standard of living is portrayed graphically in the per capita personal income statistics shown in Table 7. The average family has significantly more dollars (in real terms) to spend and spends an increasing number of those dollars on work-saving, comfort-creating, and entertainment-producing electrical devices.[2] In addition to rising living standards and real incomes the marketing activities of electrical appliance manufacturers would appear to have had some significant effect on the market saturation of electrical appliances and other electrical devices for home use. It was noted earlier that the electrical appliance industry spent an estimated $800 million advertising their wares in 1970. This was more than 40 times the estimated $20 million spent by the electric utility industry on electrical appliance advertising. In addition to their advertising effort, firms at various levels in the channel of distribution for electrical appliances expend inestimable amounts of effort on other types of promotion designed to stimulate the demand for electrical appliances. Finally, in addition to their expenditures on advertising and other types of promotion electrical appliance manufacturers have engaged in considerable product innovation over the past twenty years. This product innovation has involved the development of totally new categories of power consuming appliances and devices, and the development of new versions of established appliances which use more electricity than the originals.[1] In conclusion, it is suggested that rising living standards as evidenced by increases in real income and the marketing efforts of electrical appliance manufacturers have been the prime movers behind the increasing per home ownership of all types of appliances.

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[1] See Table 10 for appliance ownership statistics.

[2] Work-saving electrical devices are defined to include such things as electric dryers, frost free refrigerators, self cleaning ovens, etc. Comfort-creating electrical devices are defined to include air conditioners, water heaters, electric blankets, etc. Entertainment-producing electrical devices include television sets, radios, stereos, etc.

Finally, it should be noted that the analysis suggests that the price of electricity has been a major factor in the increases in the residential demand for electricity over the past 20 years. In this period of accelerating inflation in the prices of consumer goods in general, the average price paid for a kilowatt hour of electricity continued to decrease, both in current dollars and in real dollars.[2] The hypothesis that price is a significant factor in determining the per customer residential demand for electricity was borne out by the statistical analysis presented in the chapter.

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[1] New appliances introduced over the past 20 years include such items as electric carving knives, hot combs, trash compactors, heat pumps, etc. New versions of old appliances include color television sets, self-cleaning ovens, frost-free refrigerators, etc. [224, p. I-3-9]

[2] As noted earlier, the price of electricity is currently showing some tendency to rise in response to sharp rises in the costs of the industry's various inputs. The real cost of electricity to the residential consumer is expected to rise sharply over the coming decade.

On the basis of the time-series data and the statistical analysis presented in this chapter it would appear, as hypothesized earlier, that growth in the size and diversity of household appliance and electrical device stocks has been the major force behind the growth in the residential demand for electricity. It appears that advertising by electric utilities has had an insignificant effect on the residential demand for electricity. Appliance stocks would appear to have grown mainly in response to significant increases in the standard of living, as reflected in the increases in real median family income, and in response to the marketing efforts of appliance manufacturers. The analysis employed did not uncover any significant relationship between appliance stocks and advertising by electric utilities.

# Chapter V

# ANALYSIS OF INDIVIDUAL FIRM SALES DATA

## Introduction

The time-series data and the regression analysis presented in Chapter IV provided some necessary historical prospective on the relationship between per customer kilowatt hour sales and per customer advertising and the other hypothesized sales determinants. Unfortunately the analysis of Chapter IV suffers from several shortcomings. First, the time-series regression analysis suffers from the possible effects of autocorrelation so often evidenced in time-series data.[1] Second, the regression analysis presented in Chapter IV was hampered by serious multicollinearity between the various data series employed in the analysis. Third, the fact that the time-series data were for the entire privately owned electric utility industry which covers virtually the entire United States meant that it was impossible to include any measure of weather in the analysis.[2] Since weather conditions were expected to be an important determinant of residential electricity sales this is considered to be a serious omission.

In this chapter individual firm data are used to study the relationship between the per customer residential demand for electricity and the hypothesized sales determinants. Instead of looking at the variation in sales and the sales determinants series for the industry over time, this chapter involves an analysis of variation in sales and the hypothesized sales determinants between firms for certain selected time periods. In the time-series analysis the question was one of determining whether variation in the hypothesized sales determinants explained the differences in industry per customer sales between various years. The analysis presented in this chapter attempts to determine whether variation in the hypothesized sales determinants explain the observed differences in average per customer electricity demand between firms in selected years.

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[1] Autocorrelation is defined and its effects on multiple regression results are discussed in Appendix G.

[2] Weather conditions, particularly in regard to temperatures, were hypothesized to be important determinants of the residential demand for electricity.

It is suggested that cross-sectional analysis provides a possible remedy for some of the above mentioned shortcomings in the time-series analysis [235, p. 353]. Cross-sectional data, for purposes of definition, consist of observations made simultaneously [235, p. 353]. Cross-sectional analysis involves the analysis of data obtained from simultaneous measurements of a number of observational units [1, p. 4]. Aaker has noted that when cross-sectional analysis is employed "... serial correlation [autocorrelation] and carry-over effects [of advertising] are not a problem" [1, p. 4]. Cross-sectional data are not subject to autocorreleation (serial correlation) because they are generated at one point in time rather than over time [235, p. 354].

Second, Johnston has noted that models based on time-series data are often characterized by a high degree of collinearity [102, p. 164]. Johnston suggests that, if possible, the researcher switch from time-series to cross-sectional data when confronted with serious collinearity in regression models based on time-series data [102, p. 164].

Third, Theil has shown that the multicollinearity problem is aggravated when "...the underlying data are characterized by a considerable degree of aggregation" [202, p. 181]. The analysis in this chapter not only involves a change from time-series to cross-sectional data but also a change in the observational unit from the entire industry to the individual electric utility firm. This change represents a considerable reduction in the level of aggregation and thus should result in some degree of reduction in the observed collinearity between the various data series.

Finally, it should be noted that changing the observational unit from the industry to the individual firm permits the formal inclusion of some measure of weather conditions in the model. This is possible because individual firms serve relatively small geographic regions whose weather conditions can be characterized fairly accurately with Environmental Data Service data. Thus, cross-sectional analysis holds some promise of avoiding several of the problems encountered in the time-series regression analysis of Chapter IV. It is not suggested that cross-sectional regression analysis is not characterized by its own special weaknesses. It is simply suggested that the problems associated with cross-sectional regression analysis are less serious than those associated with time-series regression analysis. The special problems associated with cross-sectional regression analysis are discussed in Appendix K.

After a discussion of the technical problems involved in time-series and cross-sectional analysis the principal purpose of this chapter remains and that purpose is to study the relationship between per customer electricity sales and advertising and the other hypothesized sales determinants. The hypotheses concerning these relationships were spelled out in Chapter I and further elaborated in Chapter III and are to be evaluated further in this Chapter.[1]

The analysis of this chapter is based on the model introduced in Chapter III. This model suggests that per customer electricity sales are some function of the price of electricity, weather conditions, the per customer stock of electricity consuming devices, consumer income, and per customer advertising expenditures by electric utilities. The analysis begins with the selection of a sample of privately owned electric utility firms. After this task is completed specific data series are selected to represent each of the hypothesized sales determinants. Next the selected data series are subjected to preliminary analysis including simple correlation and other more subjective techniques for the purpose of getting some idea of association between the various series. Next the model is tested by means of multiple regression. Finally, findings and conclusions of the analysis are discussed.

## The Cross-Sectional Sample

A detailed discussion of the sample of privately owned electric utility firms employed in the analysis, including a list of the specific firms sampled and descriptions of the geographic areas served by these firms, is provided in Appendix J. A brief discussion of the sample is provided here for the sake of convenience.

The population of interest is defined to include the 212 privately owned class A and B electric utilities which operated in the continental United States in 1969. Privately owned electric utilities are those electric utilities owned by stockholders as opposed to those owned by federal, state and municipal governments [222, p. I]. Class A electric utilities include those electric utilities with annual electric operating revenues of more than \$2.5 million [222, p. V]. Class B electric utilities include those electric utilities with annual electric operating revenues of more than \$1 million but less than \$2.5 million [222, p. V].

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[1] These hypothesis are spelled out on pages 7 - 11 of Chapter I.

Publicly owned electric utility firms were eliminated from consideration because there is evidence to suggest that their behavior is sometimes based on political and social motives as opposed to the profit motivation of privately owned firms.[1] The population includes only class A and B electric utilities because statistics are not available for electric utility firms with annual electric operating revenues of less than \$1 million. The elimination of these smaller firms is not a serious limitation because they accounted for only 2 percent of the assets and revenues of the privately owned electric utility industry in 1969 [222, p. VII]. It should also be noted that privately owned class A and B electric utilities accounted for 75 percent of all power generated in the United States in 1969 [222, p. VII].

In addition to being limited to privately owned class A and B electric utilities the population of interest was divided into two subgroups: straight electric utilities and combination utilities. Straight electric utilities sell only electricity while combination utilities sell both natural gas and electricity [2, p. 688]. The population was separated into these groups because there is some reason to believe that the two types of firms can be expected to behave differently in regard to certain aspects of their operation such as promotional expenditures and pricing. Combination utilities tend to spend significantly less on promotion and charge significantly more for their service than do straight electric utilities [2, p. 688-703].[1]

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[1] This point is discussed in more detail on pages 31-32 in Chapter I. The different motives of privately and publicly owned electric utilities are also discussed in an article by Brandon [34].

In 1969 there were 134 straight electric and 78 combination privately owned class A and B electric utilities in the United States [222]. Initially random samples including half the combination utilities and half the straight electric utilities were selected. Unfortunately, problems in obtaining certain data for various firms forced the elimination of those firms from the samples. These data problems are discussed in detail in Appendix J. Samples including 28 combination and 33 straight electric utility firms were finally derived and employed in the analysis.

## Selection of Data Series

It was hypothesized earlier that per customer residential sales are a function of the price of electricity, weather conditions, the per customer stock of electricity consuming devices, per capita income, and per customer advertising expenditures. The question at this point is one of selecting actual data series to represent these hypothesized sales determinants. This process was mainly one of identifying available data series which might serve as appropriate measures of electricity prices charged by the firms in the sample, weather conditions in the market areas served by firms in the sample, the average per customer stocks of appliances owned by residential consumers in the service areas of the firms in the sample, average consumer incomes in the market areas of the firms in the sample, and per customer advertising by the firms in the sample.

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[1] The reasons for separating the population into combination and straight electric utility subgroups are spelled out in greater detail in Appendix J.

The detailed process of locating, selecting or, in some cases, deriving data series is described in Appendix M. The sales, price and advertising data series were relatively easy to choose and obtain. Per customer sales and per customer advertising data were obtained from _Statistics of Privately Owned Electric Utilities_ [222]. Selecting a measure of electricity price presented a problem in that it was necessary to decide how large a quantity of electricity to price. It was finally decided that the price of 500 kilowatt hours of electricity would be the appropriate quantity to price. This decision is predicated on the fact that the average residential customer consumed about 500 kilowatt hours of electricity per month in 1969.[1] Price data for the firms in the sample were obtained from _Typical Electric Bills_ [223].

Data regarding average ownership of the seven highest power consumption electrical appliances were obtained from a publication entitled _Statistical and Marketing Report_ published by Billboard Publications. Data on the average ownership of each of the seven appliances were converted into an index which not only reflects ownership of the various appliances but also their relative consumption rates.[2]

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[1] A more detailed discussion of this point is provided in Appendix M.

[2] A detailed discussion of how this index was computed is provided in Appendix L.

In addition to having some measure of appliance ownership or stock it seems that some measure of the ownership of central heating and air conditioning units would also be appropriate. For this reason data on the proportion of homes in the service areas of the firms in the sample which are all-electric were compiled from All-Electric Homes in the United States, a Federal Power Commission publication [219].

Several data series which might possibly reflect relevant aspects of climate or weather in the geographic areas served by the firms in the straight electric and combination utility samples were considered. These series include the following: heating degree days, cooling degree days, number of days with a maximum temperature over 90 degrees Fahrenheit, number of days with a minimum temperature under 32 degrees Fahrenheit, and average relative humidity.[1] All of these data were obtained from Climatological Data: National Summary, a publication of the U. S. Department of Commerce [214]. The mechanics of assembling these data for the geographic areas served by the various firms in the sample are discussed in Appendix L.

Finally, it was necessary to find some measure of per capita or per household income in the service areas of the firms in the sample. Median family income, used in the time-series analysis, was the desired measure. However, the fact that the geographic subdivisions served by electric utilities are different than the geographic subdivisions for which income data are reported (census tracts, Standard Metropolitan Statistical Areas, counties, states, groups of states) complicated the situation. It was possible to compile estimates, in some cases rather crude estimates, of per capita personal income in the service areas of the firms in the sample. Procedures used to derive these estimates are presented in Appendix L.

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[1] See Appendix L for complete definitions of these terms. Simply, heating degree days are a measure of the relative need for home heating and cooling degree days are a measure of the need for home air conditioning. The other three variables are basically what their names imply.

In summary, a number of different datum were collected for each firm in the sample. The data series are described above. The next question is to decide which of these series should be used in the multiple regression analysis. The following section seeks to answer this question.

## Preliminary Analysis

In this section observed relationships and simple correlations between the data series introduced in the previous section are discussed. The details of this analysis are presented in Appendix N.

### Variation in Sales Between Firms

The first observation is that there is considerable variation in average per customer kilowatt hour sales between the firms in the samples.[1] For example, average per customer kilowatt hour sales for firms in the 1969 straight electric utility sample varied from a low of 3558 kilowatt hours (Blackstone Valley Electric) to a high of 10,023 kilowatt hours (Tampa Electric Company) and averaged 6654 kilowatt hours. Similar between-firm sales variation is also found in the 1965 and 1967 data for straight electric utilities; and in 1965, 1967, and 1969 data for firms in the combination utility sample. It is, of course, suggested that variation in the hypothesized sales determinants will explain most of this between firm sales variation.

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[1] See per customer sales data in Tables M-4 through M-9 in Appendix M. Also see Table N-1 in Appendix N.

Two other observations seem appropriate at this point. First, average per customer kilowatt hour sales of electricity for the firms in the combination utility sample are significantly lower than average per customer kilowatt hour sales for the firms in the straight electric utility sample. This was true for all three years.[1] Second, as would be expected on the basis of the time-series analysis, average sales for the firms in the combination and straight electric utility samples increased greatly, by nearly 50 percent on the average, between 1965 and 1969.[2]

## Per Customer Sales and Advertising Expenditures

Simple comparisons of the per customer sales and per customer advertising data shown in Tables N-16 through N-21 in Appendix N lead to two preliminary conclusions. First, it appears that relatively high advertising expenditures do not insure high per customer sales and that high sales can be attained without the benefit of high advertising expenditures. Examination of the per customer advertising expenditures data indicates that, like per customer sales, per customer advertising expenditures vary greatly between firms. For example, in 1967, one firm in the combination utility sample, Virginia Electric and Power spent only $.31 per customer on advertising, while another (Northern States Power) spent $2.55 per customer on advertising. The firm that spent $2.55 per customer sold an average of 4957 kilowatt hours per residential customer, while the firm that spent only $.31 per customer on advertising sold an average of 5862 kilowatt hours per customer. Numerous like examples can be found by examining the data in Tables M-16 through M-21. Second, the lack of apparent association between per customer sales and per customer advertising expenditures also tends to indicate that firms in the industry do not spend some similar percent of sales on advertising.

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[1] The reasons for and significance of the observed higher sales of straight electric utilities are discussed in Appendix N and later in this chapter.

[2] See Table N-1 in Appendix 1.

Simple correlations between per customer sales and per customer advertising for the firms in both the combination and straight electric utility samples for 1965, 1967, and 1969, presented in Table N-13, generally support the thesis that there is no significant relationship between per customer sales and per customer advertising. None of the coefficients reaches statistical significance at the .05 level.

It should be noted that there is considerable between firm variation in per customer advertising (Table N-12) and that there were significant increases in average per customer advertising expenditures between 1965 and 1969. The average straight electric utility spent $.23 or 14 per cent more on per customer advertising in 1969 than it spent in 1965. The average combination utility spent $.20 or 16 percent more on per customer advertising in 1969 than it spent in 1965. Finally, it should be noted that the average straight electric utility spent significantly more per customer on advertising than the average combination utility spent in each of the three years.[1]

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[1] See Table N-11 in Appendix N.

## Per Customer Sales and the Appliance Stock Index

Simple comparisons of per customer sales and per customer appliance stock data shown in Tables M-16 through M-21 indicate that there appears to be a significant relationship between per customer sales in a market area and per customer appliance stock in that area.

Some comparisons and observations serve to illustrate the high degree of association between sales and appliance stock. In 1969 the residential customer of Blackstone Valley Electric had on the average, a smaller stock of electrical appliances than did the customers of any other straight electric utility in the sample.[1] Also in 1969, Idaho Power customers owned, on the average, a larger stock of electrical appliances than did the customers of any other straight electric utility. In 1969, Blackstone Valley Electric had the lowest per customer sales (3558 kilowatt hours) of any straight electric utility, while Idaho Power had the second highest per customer sales (9500 kilowatt hours) of any straight electric utility in the sample. Tampa Electric had the highest per customer sales (10,023 kilowatt hours) of any straight electric utility in that year; while its customers, on the average, owned the second largest stock of electrical appliances. Similar observations can be made regarding the sales - appliance stock relationships for straight electric utilities in 1965 and 1967; and for combination utilities in 1965, 1967, and 1969. In general, high per customer appliance stocks appear to be associated with high per customer sales and low appliance stocks appear to be associated with low per customer sales.

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[1] See Table M-18 in Appendix M for sales and appliance stock data on Blackstone Valley Electric, Idaho Power, and Tampa Electric.

The simple correlations between per customer sales and the per customer appliance stock index tend to confirm the above observations. These correlations, presented in Table N-6 in Appendix N, are consistently large and all statistically significant at the .01 level.

Finally, two other points should be noted. First, average appliance ownership by the customers of firms in both the straight electric and combination utility samples increased significantly over the 1965 to 1969 period.[1] Second, the average customer of the average straight electric utility had more high consumption electrical appliances than did the average customer of the average combination utility in each of the three years.

In summary, the results of this preliminary analysis suggest that the per customer stock of electrical appliances is an important determinant of per customer sales.

## Per Customer Sales and the Number of All-Electric Homes Per Customer

The number of all-electric homes per customer, as noted in Appendix L, provides another measure of the stock of electricity consuming devices in the hands of residential customers. In general, comparisons of per customer sales and the number of all-electric homes per customer indicate that per customer sales are higher in those areas where a higher proportion of homes are all-electric and lower where a lower proportion of the homes are all-electric.[2]

Simple correlations between the two variables tend to confirm the notion that there is a strong positive relationship between per customer sales and the number of all-electric homes per customer.[1] It should be noted, however, that this relationship is not as strong as the one observed between per customer sales and the per customer appliance stock index.

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[1] See Table N-5 in Appendix N.

[2] See Tables M-16 through M-21 in Appendix M.

Finally, it should be noted that there have been dramatic increases in the proportions of all-electric homes per customer in the service areas of firms in both the combination and straight electric utility samples. The average proportion of all-electric homes in the service areas of straight electric utilities has increased by 150 percent, while the average proportion of all-electric homes has increased by approximately 100 percent in the service areas of combination utility firms.[2] Also, it is observed that the average straight electric utility had twice as many all-electric homes per customer as the average combination utility in 1969.[3]

## Per Customer Kilowatt Hour Sales and the Weather

In Chapter II, arguments were presented to suggest that weather, particularly in regard to temperature conditions, is an important determinant of per customer residential sales of electricity. Unfortunately, data problems discussed earlier precluded any consideration of the effects of weather on per customer sales in the time-series analysis of industry sales data presented in Chapter IV. The analysis of individual firm data presented in this Chapter makes it possible to formally consider the sales effects of weather conditions. Five measures of weather conditions in the geographic areas served by the firms in the straight electric and combination utility samples were selected for this purpose. These data are presented in Tables M-10 through M-15. The selected measures of weather conditions include the following: heating degree days, cooling degree days, average relative humidity, number of days with a maximum temperature of more than 90 degrees Fahrenheit, and number of days with an average temperature of less than 32 degrees Fahrenheit.

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[1] See Table N-8 in Appendix N.

[2] See Table N-5 in Appendix N.

[3] See Table N-5 in Appendix N.

On the basis of analysis presented in Appendix N, heating degree days was selected as the most appropriate and efficient measure of weather conditions for purposes of this analysis.[1] Inspection of the data indicates that firms with high per customer sales tend to be located in warm areas, while firms with low sales tend to be located in cold areas. For example, in 1969, the area served by the average straight electric utility experienced 4872 heating degree days.[2] In that year the straight electric utility firm with the highest per customer kilowatt hour sales (Tampa Electric Company with 10,023 kilowatt hours per customer) experienced 1,002 heating degree days in its service area, while the firm with the lowest per customer sales (Blackstone Valley Electric Company with 3558 kilowatt hours per customer) experienced nearly 6,000 heating degree days in its service area.[3]

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[1] This statistic is computed for days that have an average temperature of less than 65 degrees fahrenheit. The number of heating degree days for such a day equal 65 minus the average temperature for that day [214, p. 79]. If the mean temperature for a particular day was 32 degrees the number of heating degree days for that day would be 33 [214, p. 62].

[2] See Table N-2 in Appendix N.

[3] See Table M-12 in Appendix M.

The reasons for this inverse relationship between sales and warmth of climate were discussed in Chapter III but are repeated here for the reader's convenience. The average household in warmer regions of the country uses more electricity than the average household in colder regions of the country for two basic reasons. First, households in warmer regions are more likely to have air conditioning and to use it more intensively than are households in colder regions [222, p. I-3-12]. Second, households in warmer regions are more likely to have electric heating than are customers in colder regions [240, p. 16]. According to Wilson, customers in warmer regions are more likely to have electric heating for the following reasons [240, p. 16].

> . . . in cold climates where the cost of home heating is large, operating costs (fuel) dominate consumption decisions, whereas in warm climates where variable costs are much lower, home owners are more influenced by fixed cost considerations and there electricity has the advantage.

The observations that per customer consumption of electricity tends to be higher in warmer regions of the country is further confirmed by simple correlation between per customer sales and heating degree days for the firms in the straight electric utility sample in 1969. The correlation between these two variables is -.63 indicating the existence of a strong and statistically significant inverse relationship between the two variables.[1]

Finally, it should be noted that straight electric utilities tend to serve areas which on the average, are significantly warmer than the areas served by combination utilities. The average area served by the average straight electric utility experiences more than 14 percent fewer heating degree days than the average area served by the average combination utility.[1] It is suggested that this difference can be accounted for by the advantages of gas over electric heating in colder areas. In other words, there is perhaps more incentive for a utility to sell both gas and electricity if it is located in a colder region of the country.

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[1] See Table N-3 in Appendix N.

## Per Customer Sales versus Price and Per Capita Income

The reasons for expecting the price of electricity and per capita income to be important determinants of per customer kilowatt hour sales were spelled out in Chapter III. Empirical support of these theses was provided by the time-series analysis presented in Chapter IV. Earlier in this chapter reasons were presented for using the price of 500 kilowatt hours as the measure of electricity price and for using per capita personal income as the appropriate measure of income for the analysis of individual firm data. Prices charged for 500 kilowatt hours by the firms in the two samples in 1965, 1967, and 1969 are shown in Tables M-16 through M-21. Per capita income data for consumers in the market areas served by the firms in the two samples are shown in the same tables.

### Per customer sales and the price of 500 kilowatt hours

It was suggested in Chapter III that per customer sales and electricity price are inversely related. The time-series analysis of Chapter IV provided some empirical support for this thesis. Inspection of the individual firm price and per customer sales data make it somewhat difficult to determine what relationship actually exists between the price of 500 kilowatt hours and per customer sales. For example,

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[1] See Table N-2 in Appendix N.

California-Pacific utilities had the highest per customer sales (11,450 kilowatt hours) of any of the combination utilities in 1969.[1] California-Pacific also charged the lowest price ($6.40) for 500 kilowatt hours of any of the combination utilities in the sample. Public Service Company of Colorado had the lowest per customer sales of any combination utility in 1969 (4480 kilowatt hours) while charging $9.62 for 500 kilowatt hours. However, a number of firms charged more than $9.62 for 500 kilowatt hours while selling more electricity per customer than Public Service Company of Colorado.[2]

Simple correlations between per customer sales and the price of 500 hours tend to confirm the fact that there is a significant negative association between the two variables in most years. In summary, it appears that per customer electricity sales tend to be higher where electricity prices are lower and that per customer sales tend to be lower where prices are higher.

### Per customer sales and per capita personal income

Comparisons of per customer sales of electric utilities and per capita personal income in the areas they serve indicate, quite unexpectedly, that the two variables appear to be negatively associated.[3] In 1969, the average straight electric utility served a market area with an average per capita income of $3453.[4] Tampa Electric, the firm with the highest per customer sales in 1969 (10,023 kilowatt hours), served an area with an average per capita income of only $3218.[1] Blackstone Valley Electric, the firm with the lowest per customer sales in 1969 (3558 kilowatt hours), served an area with an average per capita income of $3700. Finally, Commonwealth Edison served an area with an average per capita income of $4678, the highest for any area served by a straight electric utility in the sample, but sold only 5173 kilowatt hours per capita. On the basis of these few simple comparisons it would appear that sales and income are either inversely associated or not associated at all.

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[1] See Table M-21 in Appendix M.

[2] See Table M-18 in Appendix M.

[3] See Tables M-16 through M-21 in Appendix M.

[4] See Table N-9 in Appendix N.

Simple correlations between per customer income and per customer sales indicate that the two variables are inversely associated.[2] This result is difficult to explain although it should be noted that Fisher and Kaysen [72], Balestra and Nerlove [17], and Wilson [240] all obtained the same results in their studies of the relationship between energy sales and per customer income. Possible reasons for this finding are discussed in Appendix N. These reasons are summarized in the following paragraph.

There are a number of possible explanations for the inverse relationship found to exist between per customer sales and per capita income. First, the reliability of the income data employed in this study, as noted earlier, is open to question. In other words, it is possible that per capita income has been seriously over-estimated for some areas and seriously underestimated for other areas. Certainly, the possible unreliability of the income estimates could have seriously affected the results.[3] However, putting possible data problems aside for a moment, it is conceivable that an inverse relationship actually does exist between per capita income and per customer sales in the areas served by the firms in the samples in a given year. Note that this is considerably different than saying that an inverse relationship exists between per customer electricity sales and per capita personal income in a given area over time.[1]

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[1] See Table M-18 in Appendix M.

[2] See Table N-10 in Appendix N.

[3] See Appendix L for a discussion of how per capita income estimates were derived.

Three possible explanations for the negative relationship encountered between sales and income in this preliminary analysis can be suggested. First, publicly subsidized federal power projects tend, as a matter of policy, to be located in low income areas [240, p. 12]. This means that privately owned firms in adjacent low income areas are able to buy quantities of electricity for resale to their customers at artificially low wholesale rates [240, p. 12]. The point is that there is some tendency for electricity prices to be artificially low in low income areas and, thus, for sales to be artificially high (in relation to income) in low income areas. Second, it has been suggested by Fisher and Kaysen that at any given point in time high income families have more of a tendency to purchase services which would ordinarily involve power consumption (restaurant prepared meals, dry cleaning, laundry, entertainment, etc.) outside the home than do lower income families [72]. Finally, higher income areas tend to be located in colder regions of the country where per customer sales tend to be lower [17]. Per customer sales are therefore lower in those areas than income alone would lead one to expect. These three reasons provide some explanation for the inverse relationship observed between sales and income for the firms in the cross-sectional sample.[1]

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[1] The time-series results presented in Chapter IV show a positive relationship between sales and per customer income over time.

## Preliminary Analysis: Summary

The purposes of this preliminary analysis were to develop some feel for the raw data and to choose the actual data series to be employed in the multiple regression analysis. It would seem that these objectives have been basically met.

The relationships between sales and the various hypothesized sales determinants were generally as expected with the singular exception of the income-sales relationship. Possible explanations for the inverse relationship encountered between sales and income were offered and per capita personal is retained for further analysis. Multiple regression results obtained with the data series selected in this section are presented in the following section.

## Multiple Regression Results

In the previous section the variables hypothesized to be determinants of per customer residential kilowatt hour sales were subjected to a preliminary screening. The following multiple regression model emerged from this screening:

$$S/C = a + B_1P_2 + B_2W_1 + B_3A_x + B_4E + B_5Y + B_6P_4 + u$$

where: $S/C$ = per customer kilowatt hour sales

$P_2$ = price of 500 kilowatt hours

$W_1$ = heating degree days

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[1] See Appendix N for a more detailed discussion of this point.

$A_x$ = per customer stock of electrical appliances

E = all-electric homes with central heat and air conditioning per customer

$P_4$ = advertising expenditures per customer

a = constant term

$B_{1-6}$ = regression coefficients associated with the respective independent variables

u = random error term

The results obtained with this model are shown in Table 13. These results show several things. First the coefficients of multiple determination (last column of Table 13) show that the hypothesized determinants of the residential demand for electricity explain a high percentage, up to 86 percent, of the variation in per customer sales between firms.[1]

Second, the signs associated with the various regression coefficients are generally as expected.[2] The price coefficient has a negative sign in each of the six samples. This indicates that per customer sales tend to be higher in areas where prices are lower. The signs of the heating degree day coefficients are also negative in all cases. This

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[1] The coefficient of multiple determination is the multiple correlation coefficient squared. It indicates the percentage of the variation in the dependent variable which is explained by variation in the independent variables [84, p. 351].

[2] The regression coefficient associated with a particular independent variable indicates how much change in the dependent variable can be expected in response to a one unit change in the particular independent variable [84, p. 345]. For example, Table 13 shows that the regression coefficient associated with the price of 500 kilowatt hours in the 1969 SE sample is -246. This means that, on the average, per customer kilowatt hour sales can be expected to decline by 246 kilowatt hours in response to a one dollar increase in price.

## TABLE 13

## MULTIPLE REGRESSION RESULTS FOR THE SIX SAMPLES WITH PER CUSTOMER KILOWATT HOUR SALES (S/C) AS THE DEPENDENT VARIABLE AND THE PRICE OF 500 KILOWATT ($P_2$), HEATING DEGREE DAYS ($W_1$), PER CUSTOMER APPLIANCE STOCK ($A_x$), ALL-ELECTRIC HOMES PER CUSTOMER (E), PER CAPITA PERSONAL INCOME (Y), AND PER CUSTOMER ADVERTISING EXPENDITURES ($P_4$) AS THE INDEPENDENT VARIABLES

| Sample | Constant Term | Regression Coefficients ($B_1$-$B_6$) Associated With Independent Variables | | | | | | Coefficient of Multiple Determination |
|---|---|---|---|---|---|---|---|---|
| | | Price | Heating Degree Days | Appliance Stock | All-Electric Homes | Per Capita Personal Income | Per Customer Advertising | $R^2$ |
| 1969 SE | 7131** | -247* | -.38** | 7813** | 3970 | .24 | 223 | .78*** |
| 1969 C | 7879** | - 73 | -.07 | 4390** | 20991** | -.65** | 237 | .78*** |
| 1967 SE | 5249** | -210** | -.18** | 7327** | 2037 | .18 | 333 | .76*** |
| 1967 C | 6468** | -152* | -.06 | 5903** | 16379** | -.34 | 37 | .84*** |
| 1965 SE | 4770** | -191** | -.08* | 7808** | 418 | .01 | 264 | .86*** |
| 1965 C | 6442** | -207** | -.03 | 5661** | 7721** | -.42 | 217 | .82*** |

* Significant at .05 level (t test)
** Significant at .01 level (t test)
*** Significant at .01 level (F test)

indicates that per capita consumption of electricity tends to be higher in warmer regions. This was expected in view of the analysis of the effects of weather on per capita sales presented in Appendix N. The basic reasons for the lower consumption in cold areas are: 1) the fact that on the basis of operating costs electric heating is not competitive with gas and fuel oil heat in colder regions, and; 2) the lower need for air conditioning in colder regions. The regression coefficients associated with appliance stock and all-electric homes per customer are positive in all cases. This indicates, as one would expect, that per customer usage of electricity tends to be higher in those areas where the average customer has more appliances or where a higher proportion of the homes are all-electric. The regression coefficients associated with per capita personal income are mixed in sign. The signs of the income regression coefficients are positive for all the straight electric utility samples and negative for all the combination utility samples. The possible reasons for the negative relationship between income and sales were discussed earlier. Finally, the regression coefficients associated with per customer advertising expenditures are positive, indicating that those firms which spend higher amounts on advertising tend to have higher per customer sales. It should be noted that none of the regression coefficients associated with per customer advertising expenditures are statistically significant at the .05 level.

Finally, the results shown in Table 13 indicate the possible existence of collinearity between the variable all-electric homes per customer and the variable per customer stock of appliances. The possibility of collinearity is suggested by the erratic changes in the magnitude of the regression coefficients associated with the number of all-electric homes per customer. Perhaps this collinearity should have been anticipated. One should expect a fairly high correlation between the number of all-electric homes per customer and the per customer stock of electrical appliances. It seems reasonable to predict that the per customer stock of electrical appliances will be higher in areas where a relatively high percentage of the homes are all-electric. Simple correlations between the number of all-electric homes per customer and the per customer stock of electrical appliances are shown in Table 14.

The correlations shown in Table 14 indicate that the two variables are indeed collinear. This collinearity makes it impossible to disentangle the separate effects of the two variables on sales sources. One way to solve this problem is to drop one of the two variables. Since the two variables appear to be somewhat redundant, dropping one of them would appear to be in keeping with the law of parsimony of variables from the philosophy of science [73, p. 58]. The number of all-electric homes per customer was dropped from the analysis because of its inferior statistical performance and because it is a less generalized measure of the stock of electricity consuming devices. Every home has some electrical appliances but only a small fraction of the homes in this country are all-electric.

The truncated version of the original model is as follows:

$$S/C = a + B_1P_2 + B_2W_1 + B_3A_x + B_4Y + u$$

where: $S/C$ = per customer kilowatt hour sales

$P_2$ = price of 500 kilowatt hour sales

$W_1$ = heating degree days

$A_x$ = per customer appliance stock index

$Y$ = per capita personal income

### TABLE 14

### SIMPLE CORRELATIONS BETWEEN THE NUMBER OF ALL-ELECTRIC HOMES PER CUSTOMER AND THE PER CUSTOMER STOCK OF APPLIANCES FOR THE FIRMS IN EACH OF THE SIX SAMPLES

| Sample | Correlation Coefficients |
|---|---|
| 1969 SE | .56 |
| 1969 C | .46 |
| 1967 SE | .58 |
| 1967 C | .54 |
| 1965 SE | .57 |
| 1965 C | .47 |

$P_4$ = per customer advertising expenditures

a = constant term

$B_{1-5}$ = regression coefficients associated with the respective independent variables

u = random error term

Results obtained with this model are shown in Table 15. These results are comparable to those presented in Table 13 with two important exceptions. The number of all-electric homes per customer is of course missing from the model and the values of the regression coefficients associated with the per customer appliance stock are now more consistent between samples.

The hypothesized determinants of per customer sales explain a high proportion of the variation in per customer sales between firms in all the samples. The signs of the regression coefficients are appropriate, with the exception of three of the regression coefficients associated with per capita personal income. However, it is difficult to determine which of the variables are most important in determining per customer kilowatt hour sales. This difficulty can be explained by the fact that the variables are scaled in different units. Some of the variables are scaled in dollars, one in heating degree days, and one is an index that varies from zero to one. This problem was solved by standardizing the individual data series and recomputing the regression coefficients.

Leabo has commented on the above problems as follows [123, pp. 473-474]:

> As indicated in the introductory section the b's are simply weights expressing the influence of the independent variables as they are combined into an estimate of the dependent variable. In using the b values, we do encounter some difficulties. The units in which the b

## TABLE 15

## MULTIPLE REGRESSION RESULTS FOR THE SIX SAMPLES WITH PER CUSTOMER KILOWATT HOUR SALES (S/C) AS THE DEPENDENT VARIABLE AND THE PRICE OF 500 KILOWATT HOURS ($P_2$), PER CUSTOMER STOCK OF ELECTRICAL APPLIANCES ($A_x$), HEATING DEGREE DAYS ($W_1$), PER CAPITA PERSONAL INCOME (Y), AND PER CUSTOMER ADVERTISING EXPENDITURES ($P_4$) AS THE INDEPENDENT VARIABLES

| Sample | Constant Term | Regression Coefficients Associated With The Listed Independent Variables | | | | | Coefficient of Multiple Determination |
|---|---|---|---|---|---|---|---|
| | | Price | Heating Degree Days | Appliance Stock | Per Capita Personal Income | Per Customer Advertising | |
| 1969 SE | 6504** | -226* | -.43** | 8820** | .39 | 223 | .77 |
| 1969 C | 10193** | -293** | -.22** | 7723** | -.68* | 501 | .70 |
| 1967 SE | 4939** | -194* | -.21** | 7711** | .26 | 321 | .77 |
| 1967 C | 7973** | -263** | -.21** | 8911** | -.37 | 89 | .78 |
| 1965 SE | 4731** | -187** | -.09** | 7862** | .02 | 259 | .86 |
| 1965 C | 7972** | -329** | -.11 | 7220** | -.47 | 306 | .80 |

* Significant at .05 level (t test)
** Significant at .01 level (t test)
*** Significant at .01 level (F test)

> values are measured may be different, and their respective variations may differ greatly. As a result, the b's do not indicate the actual comparative significance of each independent variable.

Any data series can be standardized by subtracting the mean of the series from each successive unit of the series and dividing the resulting values by the standard deviation of the series [123, p. 175]. This process is referred to as standardization because any data series subjected to this procedure will be transformed into a new series with a mean of zero and a standard deviation of one [84, p. 359]. Recomputing the regression parameters using the standardized data series provides regression coefficients which reflect the relative effect of the various independent variables on the dependent variable [123, pp. 473-474]. Regression coefficients for the independent variables in the model, computed from standardized data are shown in Table 16. These standardized coefficients show several things. First, the coefficients in Table 16 indicate that, of all the independent variables, per customer appliance stock has the greatest effect on per customer sales. Second, the model indicates that price has had a decreasingly important effect on per customer kilowatt hour sales, over time, while heating degree days have had an increasingly important effect on per customer sales. Of the five independent variables, the price of 500 kilowatt hours had the second greatest effect on per customer sales in both the 1965 straight electric and combination utility samples. Heating degree days ranked third among the variables as a determinant of per customer sales in 1965. In the 1969 straight electric and combination utility samples, heating degree days was the second most important per customer sales determinant, while the price of 500 kilowatt hours had declined to third place as a sales determinant.

## TABLE 16

## REGRESSION COEFFICIENTS COMPUTED FROM STANDARDIZED DATA

| Sample | Price | Heating Degree Days | Appliance Stock | Per Capita Personal Income | Per Customer Advertising |
|---|---|---|---|---|---|
| 1969 SE | -.152 | -.525 | .712 | .110 | .057 |
| 1969 C | -.278 | -.294 | .532 | -.212 | .287 |
| 1967 SE | -.176 | -.344 | .772 | .080 | .107 |
| 1967 C | -.245 | -.312 | .794 | -.115 | .047 |
| 1965 SE | -.203 | -.157 | .917 | .006 | .099 |
| 1965 C | -.376 | -.170 | .690 | -.122 | .162 |

The declining importance of the price of 500 kilowatt hours might be explained by the fact that the price of 500 kilowatt hours declined as a percent of per capita personal income between 1965 and 1969 [224, p. VI]. The increasing importance of weather as a determinant of per customer sales is, perhaps, attributable to the increased usage of home air conditioning between 1965 and 1969 (see Table 7 in Chapter IV). Finally, both per capita personal income and per customer advertising consistently rank behind the other three variables as sales determinants.

## Summary and Conclusions

This chapter involved analysis of the relationships between per customer residential electricity sales and a set of hypothesized sales determinants for a sample of straight electric and combination utilities. Data for three years -- 1965, 1967, 1969 -- were analyzed by means of multiple regression and other less formal techniques. The basic objective of the analysis was to determine whether variation in the hypothesized sales determinants explain the considerable observed variation in per customer sales between firms.

The chapter began with a discussion of the details of the sample of firms employed in the analysis. Next, specific data series were selected to represent each of the general sales determinants in the model. The selection of data series to represent per customer kilowatt sales, per customer advertising expenditures, and the price of electricity presented no serious problems. The selection of data series to represent the income variable, the appliance stock variable, and the weather variable did present some problems. These problems are discussed in some detail in the chapter.

Third, raw data for the firms in the sample were inspected for the purpose of discerning basis relationships between the variables. Inspection of the raw data indicated the following:

1. Average per customer residential sales vary dramatically between firms.
2. The average residential stock of electrical appliances in the service areas of the firms in the sample appear to be more closely associated with the average per customer

sales of these firms than any of the other independent variables.

3. There appears to be little or no association between a firm's per customer sales and its per customer advertising expenditures.
4. There appears to be a negative association between the coldness of a particular area's climate, as measured by heating degree days and average per customer kilowatt hour sales in that area.
5. Per customer sales and the price of 500 kilowatt hours of electricity appear to be inversely related.
6. It is difficult to arrive at any conclusions regarding the relationship between per customer sales and per capita personal income on the basis of inspection of the raw data. It appears that there is no significant relationship between the two variables.

The simple correlation and multiple regression analysis confirmed the above observations. The multiple regression results (see Tables 14, 15, 16) indicate that, of the list of sales determinants studied, the per customer stock of electrical appliances is by far the most significant determinant of per customer energy sales. This was true for both combination and straight electric utilities in all three years. Heating degree days was the second most significant sales determinant for both combination and straight electric utilities in 1969. However, this has not always been the case. The regression analysis indicated that in 1965 price was the second most important sales determinant for both straight electric and combination utilities, while heating degree days was the third most important sales determinant for both types of utilities in 1965. According to the regression analysis, the relative importance of heating degree days as a sales determinant seems to have steadily increased, while the relative importance of price as a sales determinant has steadily declined over the 1965 to 1969 period.

The increasing importance of weather and the decreasing importance of price as sales determinants can be explained by reference to changes which have taken place in the market over the period. Weather has become an increasingly important determinant of per customer sales due to the increased number of electric heating and air conditioning installations. In turn, it may be argued that the price of 500 kilowatt hours has become a decreasingly important determinant of household electricity sales because the price of 500 kilowatt hours has become a decreasingly smaller percentage of per capita personal income in the service areas of all the firms in both the combination and straight electric utility samples.

Both the simple correlation and multiple regression analysis failed to show any significant relationship between per customer sales and per customer advertising expenditures. Finally, the simple correlation and multiple regression analysis indicate that there is not significant relationship between per customer power sales and per capita income. However, as noted in the text, this result must be interpreted to mean that differences in per capita personal income between the service areas of the firms in the sample fail to be a significant factor in explaining the differences in per customer sales for the firms in the sample. The time-series analysis presented in Chapter IV indicated that per capita income is an important determinant of per customer residential sales over time. Possible explanations for the inverse relationship found to exist between per capita income and per customer sales for the firms in the straight electric utility sample were presented in the text. It should be noted that income in an area is to some extent reflected in the appliance stock index. There is some tendency for the appliance stock index to be higher in areas where incomes are higher.

The empirical results presented in this chapter are generally in agreement with the hypotheses presented in Chapter I. These results are summarized as follows:

1. The per customer stock of residential appliances is the single most important determinant of residential electricity sales. The average per customer appliance stock in a particular area is positively related to per customer sales in that area.
2. Weather is the second most important determinant of per customer sales. Per customer sales in an area are inversely related to the number of heating degree days (days when home heating is required) experienced in that area. In other words, the empirical analysis tends to confirm the fact that average per customer sales tend to be higher in warmer regions of the country and lower in colder regions of the country.
3. Electricity price, at least in the ranges experienced in recent years, is the third most important determinant of residential electricity sales. Per customer sales are inversely related to electricity price.

4. There appears to be no significant relationship between per customer sales and per customer advertising expenditures by electric utilities.
5. Per customer income was shown in the multiple regression analysis to have no significant effect on per customer sales of electricity. As noted earlier, this result should not be interpreted to mean that income does not have a significant effect on per customer residential electricity sales over time. Changes in income are reflected in changes in the per customer stock of electrical appliances over time and income was shown to be associated with changes in per customer sales in the time-series analysis of Chapter IV.

The major conclusion based on the results presented in this chapter is that the driving forces behind the increasing residential demand for electric power are factors which to a large extent are outside the control of the individual electric utility firm. Since these factors -- the residential stock of electrical appliances, weather conditions, per capita income -- are outside the control of individual electric utility firms, they are also outside the control of the agencies that regulate the activities of electric utility firms.

A second conclusion, suggested by the analysis presented in this chapter, is that the elimination of electric utility advertising designed to stimulate sales is likely to have little effect on residential electricity sales. It might also be argued that, since advertising by electric utilities appears to be ineffective in getting consumers to change their behavior so that they use more electricity, it is also unlikely that electric utility advertising can be effectively employed as a tool to change people's behavior so that they use less electricity or so that they conserve electricity.

The implications of the results presented in this chapter are discussed in greater detail, particularly in regard to their implications for public policy, in Chapter VI.

# CHAPTER VI

# SUMMARY AND CONCLUSIONS

## Summary

### Chapter One

Chapter I dealt with the origin and purposes of the study, the literature in the field, the research design employed in the study, and the limitations of the study.

### Origins of the study

The study was prompted by two sets of considerations. First, there are the concerns over electricity sales gains expressed by environmental, ecological groups, and those people concerned with power shortages. These groups believe, in the main, that the advertising and sales promotion efforts of electric utilities should be totally eliminated. Second, some consumer groups have expressed the concern that electric utility advertising and sales promotion represent consumer exploitation. These groups argue that electric utilities do not need to advertise because they are monopolies and that every home in the country has to use at least some electricity. These critics argue that electric utility advertising has no significant effect on sales and adds only to the costs of electricity service.

The electric utility industry tends to take the position that their advertising stimulates sales significantly and reduces the costs of electricity to consumers. Cost reductions are said to result from more efficient utilization of capacity and the opportunity to exploit scale economies.

Regulatory agencies have typically accepted the industry argument. However, recent years have witnessed a tendency on the part of regulatory commissions to accept the antiadvertising stance of environmentalists, conservationists, and those concerned with power shortages.

It was suggested that the positions of regulatory commissions on the question of electric utility advertising are too often based on political considerations rather than objective knowledge of the effects of electric utility advertising.

Research purposes and hypotheses

Prompted by the above considerations, the major purpose of this dissertation was to examine the relationship between residential electricity sales and electric utility advertising. The secondary purpose of this research effort was to identify and examine effects of electric utility advertising not directly related to sales.

Hypotheses were suggested in regard to both of these research purposes. First, it was hypothesized that electric utility advertising has been an insignificant factor in the growth of residential electricity sales, and that residential electricity sales have grown in response to a number of factors largely outside the direct control of electric utility firms. These factors and their hypothesized effects on residential electricity sales were discussed in some detail; they include the residential stock of electrical appliances, consumer income, weather conditions, competitor's actions, and the price of electricity.[1]

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[1] See pages eight through ten in Chapter I.

Second, it was suggested that electric utility advertising has effects other than those connected directly with sales which might justify or condemn its use from the standpoint of consumer welfare.

It was noted that there is little existing literature directly pertinent to these hypotheses. This lack of research does not establish a need for the study by itself. However, considered in light of the problems connected with the rapid increases in the demand for electricity and the reasons for the lack of research in regard to the sales effects of utility advertising and other electricity sales determinants, the lack of research in the field does provide some indication of the need for research.[1]

### Research design

The research design for testing the two hypotheses outlined above was presented in the chapter. In regard to the sales effects of advertising and the effects of the other hypothesized sales determinants, it was suggested that these hypotheses be tested empirically. Time-series data for the industry and cross-sectional data for a sample of individual electric utility firms were to be used. Multiple regression was selected as the principal tool of analysis.

The basic idea behind the research design for testing the main hypotheses was to build a case for the existence of causal relationships between sales and some of the hypothesized sales determinants and a case for the lack of causal relationships between electricity sales and certain other factors.

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[1] See pages fourteen and fifteen in Chapter I for a discussion of reasons for the lack of research into the sales effects of electric utility advertising.

Green has noted that three kinds of evidence can be used for drawing inferences about causal relationships. The three types of evidence include: 1) associative variation; 2) sequence of events; and 3) absence of other causal factors [84, p. 79]. Wentz suggests a similar list including: 1) evidence of concomitant variation -- that the causal variable and the dependent variable are associated; 2) evidence that the dependent variable did not occur before the causal variable; and 3) evidence ruling out other factors as possible determining conditions of the dependent variable [235, pp. 9, 321]. Green has also made the following comment in regard to determining whether a true causal relationship exists between two or more variables [84, p. 330]:

> If the data are collected in such a way that outside variables are not controlled, the imputation of a causal relationship between two or more variables must rest on extrastatistical considerations and the judgement of the analyst; he must assess the reasonableness of the relationship and reach a conclusion as to whether causation exists.

Chapter IV and V deal primarily with evaluating or determining whether per customer sales are associated with each of the independent variables and whether the dependent variable occurred before the independent variable. Simple correlation, multiple regression, and other less formal techniques are used for this purpose.[1] Extrastatistical evidence in support of the reasonableness of the hypotheses is provided in Chapter III, and to a more limited extent in Chapters IV and V.

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[1] Bass [20], Blattberg and Stivers [28], Buzzell [39], Echelberger and Elwood [65], Hughes [98], Palda [152], Quandt [160], Sexton [176], Simon [184, 185], Tull [205], and Twedt and Knitter [207] provide authority for the use of multiple regression to examine the sales effects of advertising and other sales determinants.

The secondary hypothesis of this dissertation -- that advertising has effects other than those associated directly with sales -- was tested in a much less rigorous fashion. The approach taken was to first establish the fact, from authoritative sources, that advertising has potential effects other than those related to sales stimulation. Second, it was necessary to demonstrate that these potential nonsales effects are applicable to the special case of electric utility advertising. These hypotheses were tested in Chapter II.

It was not felt that the research designs to test the primary and secondary hypotheses would provide absolute proof of their validity or invalidity, only that the proposed research designs would produce a weight of evidence in favor of or against the hypotheses.

### Limitations of the study

Finally, the limitations inherent in the study or the research design were discussed. The limitations discussed included: time limitations, geographic limitations, limitation to privately owned firms, limitation to the electric utility advertising-residential sales relationship, limitations inherent in using dollar advertising expenditures as a measure of relative advertising intensity, the limitations of regression as a tool of analysis, and various other limitations inherent in the data or the research design.

### Chapter Two

A number of topics were considered in Chapter II. First, the fact that electric utilities are a special and unique category of business firms subject to special constraints and vested with special powers was established. It was also shown that these special characteristics of electric utilities can be traced to the fact that they are natural monopolies. They are termed natural monopolies because monopoly is the natural outcome of competition between electric utilities. Monopoly is the natural outcome of competition because electric utilities operate most efficiently as monopolies. Electric utilities operate most efficiently as monopolies because they experience decreasing costs in both the short-run and the long-run. Short-run decreasing costs result from more efficient utilization of fixed facilities. Long-run decreasing costs result from the large scale economies associated with electric power production. Economic efficiency, therefore, dictates that electric utilities operate as monopolies.

On the other hand, economic equity requires that electric utilities be regulated so that they cannot take advantage of their monopoly power, and to insure that consumers receive the benefit of low cost monopoly production. Electric utilities are primarily regulated by means of constraints on their prices and profits.

A second major point of the chapter was that electric utilities advertise under special circumstances. These special circumstances are established by several facts including the following: 1) electric utilities advertise a service which is essential to residential users and for which residential users have no alternative source of supply; 2) due to the manner in which electric utilities are regulated (essentially cost plus) they are in a position to extract all of their advertising costs from consumers whether those expenditures are effective or not and whether electricity consumers desire that advertising or not.

The third, and major, part of the chapter was devoted to identifying and evaluating the different functions and effects of electric utility advertising. It was noted that advertising might be used by electric utilities to perform a number of functions including the following: 1) advertising might be construed as a form of free speech, a means by which electric utilities might communicate with the public or their customers (the two are virtually synonomous); 2) advertising is a necessary competitive tool if electric utilities are to effectively compete with other types of energy; 3) advertising by electric utilities provides needed product information to the residential users of electricity; 4) electric utility advertising might be used to enhance the need satisfying power of electricity service by enhancing the image of electricity as an energy service or by reducing various types of risk for the consumer; and 5) it was suggested that electric utilities might be able to reduce their production costs through the use of advertising.

The analysis of these potential functions of electric utility advertising indicated that hypothetically all of the above functions except the first have some merit from the standpoint of enhanced consumer welfare. This was particularly true in regard to advertising's role as a means of providing consumers with energy use information.

The major conclusions of this chapter are summarized below:

1. Electric utilities represent a special category of business firms.
2. Electric utilities advertise under extraordinary conditions. They advertise to a captive market and are able to recoup all their advertising expenditures

whether they are effective or desired or not.

3. Electric utility advertising may serve a number of functions which have potential positive effects on consumer welfare. Sales stimulation with its possible negative effects on the environment is just one of the functions. Regulatory commissions should remember that advertising has other effects than those associated with sales stimulation, and that some of these other effects may have positive effects on consumer welfare.

### Chapter Three

The major objective of Chapter III was to provide extrastatistical evidence of the reasonableness of the hypothesized relationships between residential electricity sales and the suggested determinants of those sales.

The chapter began with a general discussion of the value of models as tools of analysis for social science research. Next, the general marketing sales model was discussed. This model suggests that the sales of a firm's product or service are some function of the firm's product, price, place, and promotion policies; and some function of a set of factors outside the firm's control -- economic conditions, consumer incomes, weather conditions, consumer tastes, etc.

Third, it was necessary to move from the general marketing sales model to a specific model which included the specific determinants of residential electricity sales. A large number of variables were screened and from this screening a model emerged. This model indicates that per customer residential sales of electricity are a function of the price of some quantity of electricity, per customer advertising expenditures, the average per customer stock of electrical appliances, consumer income, and temperature conditions.

Next, evidence was presented to demonstrate the reasonableness of the predicted relationships between per customer sales and the hypothesized sales determinants. This evidence draws upon marketing theory, economic theory, the findings of empirical studies, and logic to demonstrate the probable existence of causal relationships between the independent variables and the dependent variable.

The evidence presented in Chapter III suggests that the per customer stock of electrical appliances is the single most important determinant of residential electricity sales. A positive relationship can reasonably be expected between per customer sales and the average per customer stock of electrical appliances in a particular area. Per capita income is, perhaps, the second most important determinant of per customer sales. Again, a positive relationship should be expected. Next in importance come the price of electricity and weather conditions. Per customer sales should be higher where prices are lower or where climate is warmer. Finally, per customer advertising expenditures by electric utilities were not expected to be a significant determinant of residential electricity sales on the basis of evidence presented. To the extent that advertising does affect sales, the relationship was predicted to be a positive one.

The evidence presented in Chapter III provided some authority for a list of hypothesized sales determinants. The evidence also suggests that per customer residential sales of electricity are for the most part determined by factors outside the control of electric utility firms. This suggests that the actions of regulatory commissions in regard to restricting electric utility advertising are not likely to have a significant dampening effect on the residential demand for electricity.

## Chapter Four

Two objectives were pursued in this chapter based on the analysis of time-series data for the entire privately owned electric utility industry. First, the per customer sales series, sales determinant series, and selected measures of industry performance were scrutinized for the purpose of determining basic trends in the structure of the industry. The second objective of the chapter was to attempt to measure, through the use of multiple regression, the degree and magnitude of association between per customer sales and each of the hypothesized sales determinants.

In regard to the first objective, the following observations were made:

1. Residential sales have quadrupled over the 1951-1970 period.
2. Total sales gains have come primarily from increases in per customer sales rather than from increases in the number of customers.
3. Residential electricity sales grew at the expense of efficient plant utilization in that a disproportionately high percentage of the industry's sales gains came as additions to peak as opposed to off-peak loads. This has been a primary factor in the relative power shortages

which have developed in certain parts of the country.

4. Comparisons of changes in the raw data series for the industry indicate that changes in the per customer stock of electrical appliances are more closely associated with changes in per customer electricity sales than are any of the other hypothesized sales determinants. Per customer advertising expenditures and per customer sales do not appear to be associated in any significant way.

The major finding in regard to the first objective is that residential sales are growing at a rapid rate and are growing largely in response to factors outside the control of individual electric utility firms. The residential stock of electrical appliances and electricity consuming devices would appear to have been the most important single determinant of residential electricity sales over the 1951-1970 period. This stock appears to have grown largely in response to the sales promotion and product innovation efforts of appliance manufacturers, and in response to rising consumer incomes.

The multiple regression analysis provided further evidence to support the contention that the residential stock of electrical appliances was the most important single determinant of residential electricity sales over the 1951-1970 period. The analysis indicated the existence of strong positive association between the two variables. The multiple regression analysis also indicated the following:

1. The per customer stock of electrical appliances is more closely associated with and has a greater impact on per customer sales than are any of the other hypothesized sales determinants.

2. The price of 250 kilowatt hours is inversely associated with per customer sales.
3. Median family income is positively associated with per customer sales.
4. The association between per customer sales and per customer advertising expenditures is not significant, but it is positive. It should be noted here that per customer sales continued to increase unabated after real per customer advertising expenditures began to decline in 1966.[1]

In conclusion, the time-series analysis presented in Chapter IV tends to support the thesis that the major force behind the rapid growth in the residential demand for electricity has been and will continue to be the increasing stock of electrical appliances found in the average home. There appears to be two major forces behind this increasing stock of electrical appliances: rising consumer incomes and living standards; and the marketing effort and product innovation of electrical appliance manufacturers. The elimination of electric utility advertising is not likely to have much effect on the growth of residential electricity sales.

### Chapter Five

The time-series analysis of Chapter IV suffered from weaknesses (autocorrelation and multicollinearity) which cast some doubt on the validity of the results obtained. These weaknesses were anticipated and a cross-sectional study was included in the original research design as an additional test of the hypotheses. The cross-sectional study was presented in Chapter V and again the objectives were to attempt to measure the degree of association between sales and the hypothesized sales determinants, and to measure the effects of changes in each of the hypothesized sales determinants on per customer sales. In the time-series study the question was one of finding out if the changes in the hypothesized sales determinants over time explained the changes in per customer sales over time. In the cross-sectional study the question was one of determining whether between firm differences in the sales determinant series explained the differences in per customer electricity sales between firms. In order to answer this question a sample, including 28 combination and 33 straight electric utilities, was selected from the universe of 212 privately owned electric utilities. Next, sales, price, advertising, appliance stock, income, and weather data were collected for these 61 firms. These data were collected for three recent years -- 1965, 1967, and 1969.

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[1] The effects of weather were not formally considered in the time-series analysis because there are no weather data which accurately reflect temperature conditions in the entire country.

Preliminary analysis of the raw data indicated that the relationships between sales and the sales determinant series were generally as hypothesized with the possible exception of the income-sales relationship.

The multiple regression results, shown in Tables 13 through 16 in Chapter V indicate the following:

1. Between firm variation in average appliance stock, heating degree days, and electricity price explain most of the between firm variation in per customer sales. The association between each of the above variables and per

customer sales is statistically significant at the .01 level.

2. The per customer stock of residential electrical appliances, according to the regression analysis, is the single most important determinant of residential electricity sales (Table 16). The association between these two variables was positive as expected.
3. The regression results indicate that weather as measured by heating degree days is the second most important determinant of per customer electricity sales. Average per customer sales tend to be higher in warm areas of the country.
4. Electricity price, at least in the ranges experienced in recent years, appears to be the third most important determinant of residential electricity sales. Per customer sales, as expected, appear to be inversely related to the price of electricity.
5. Per customer sales and per customer advertising expenditures are not associated in any significant way.
6. The multiple regression analysis indicates that there is no significant association between per capita income and per customer sales. This result, as noted earlier, should not be interpreted to mean that income does not have a significant effect on per customer electricity sales over time. Changes in income are reflected in changes in the per customer stock of electrical appliances over time, and income was shown to be associated with

> changes in per customer sales in the time-series analysis of Chapter IV. Reasons for the perplexing relationship between sales and income encountered in the cross-sectional study were presented in Chapter V.

The major conclusion, based on the analysis presented in Chapter V, was that the driving forces behind the increasing residential demand for electric power are factors which to a large extent are outside the control of the individual electric utility firm. Since these factors -- the residential stock of electrical appliances, weather conditions, per capita income -- are outside the control of individual electric utility firms, they are also outside the control of the agencies that regulate the activities of electric utility firms.

A second conclusion, suggested by the analysis presented in Chapter V, is that the elimination of electric utility advertising designed to stimulate sales is likely to have little effect on residential electricity sales. It might also be argued that since advertising by electric utilities appears to be ineffective in getting consumers to change their behavior so that they use more electricity, it is also unlikely that electric utility advertising can be effectively employed as a tool to change people's behavior so that they use less electricity or so that they conserve electricity.

## Conclusions

### The Determinants of Residential Electricity Sales

Multiple regression analysis and other examination of time-series data for the electric utility industry and cross-sectional data for a sample of electric utility firms tend to support the thesis that residential electricity sales are for the most determined by factors outside the control of individual electric utility firms.

More specifically the findings of this study indicate that per customer residential electricity sales are primarily a function of the average residential stock of electrical appliances, warmth of climate and the price of electricity in descending order of importance. The prominence of these factors as determinants of residential electricity sales is supported by literature in the field and the empirical analysis noted above. The study also indicates, though less strongly or on the basis of less impressive evidence, that the average residential stock of electrical appliances is largely a function of per capita personal income and the promotion and product innovation efforts of electrical appliance manufacturers.[1] There is no evidence, other than the unsupported statements of some electric utility executives, a few regulatory commissioners, and some environmental group spokesmen to support the contention that electric utility advertising has a significant effect on residential electricity sales.

Because electric utility advertising has no significant effect on electricity sales it would seem to follow that this advertising can have no significant favorable effect on electricity production costs and that advertising by electric utilities can only increase the costs of electricity service. Comments on the findings in regard to the secondary hypothesis of the study provide some indication as to whether consumers receive some benefit or benefits from electric utility advertising to offset the cost increases attributable to electric utility advertising.

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[1] In 1969 electrical appliance manufacturers and retailers spent approximately $800 million advertising their products [48, 106, 213]. The electric utility industry spent $20 million on appliances advertising in 1969.

## Other Effects and Functions of Electric Utility Advertising

Examination of secondary evidence -- primarily literature in marketing and economics regarding the hypothetical effects of advertising in general -- indicates that advertising has effects other than those associated with sales stimulation and that some of these other effects have considerable potential value to electricity consumers. Specifically, it was concluded that electric utility advertising's role as a source of product use information is of considerable potential value to residential electricity consumers. It was noted that only some fraction of electric utility advertising is presently devoted to this purpose. Second, it was concluded that electric utility advertising may be of potential value to electricity consumers because of its possible power to enhance the image and want satisfying ability of electricity service, and its possible power to reduce the consumer's risk in connection with electric power purchase and consumption.

Third, it was concluded that as long as the sellers of other types of energy (natural gas, fuel oil) are permitted to advertise that it would be unequitable to take this competitive tool away from electric utilities.

Finally, advertising's function as a form of free speech was considered in the context of the constraints under which electric utilities operate. It was noted that the various proposals to limit electric utility advertising do not require outright prohibition of advertising. These proposals only prohibit the deduction of certain types of advertising expenses in arriving at the allowable rate of return. It was concluded that the free speech argument when considered in the light of all the facts has little merit as a defense of the right of electric utilities to deduct these expenditures in arriving at allowable earnings.

## Implications of the Study

The study has several implications for public policymakers. First, analysis of the determinants of residential electricity sales indicates that the prohibition or elimination of electric utility advertising is not likely to have much effect on the rapid increases in residential electricity sales. It, therefore, follows that the elimination of electric utility advertising would not provide any significant relief from the various problems -- power shortages, natural resource consumption, air and water pollution -- which have brought electric utility advertising under the scrutiny of regulatory commissions. This is not to say that electric utilities should be permitted to do whatever they want in regard to advertising. It would seem that electric utility advertising which has sales stimulation as its sole objective is highly undesirable in areas of the country that are presently experiencing power shortages and at least questionable in other parts of the country.

Second, analysis of the potential effects of electric utility advertising suggests on the other hand that prohibition of electric utility advertising may also be undesirable. The major basis for this statement rests on the evidence presented in Chapter II regarding the potential informational and educational roles of electric utility advertising. Electric utilities have in the past devoted at least a small portion of their advertising budgets to the education of consumers in regard to the safe and efficient use of electricity [175, 177]. In certain parts of the country, electric utility firms (Consolidated Edison in New York for example) have devoted increasing amounts of their advertising budgets to advertising campaigns designed to educate consumers in the efficient use of electricity [201].

It is too early to judge the effectiveness of these efforts, but it would appear that advertising might play an important role as a means of educating electricity consumers in energy conservation. This is not to suggest that the full responsibility for educating consumers in regard to energy conservation should necessarily fall upon electric utility firms. Only that there are instances in which company self-interest is linked with wise and efficient energy use by consumers and that these situations provide the utility firm with an opportunity to use advertising to serve not only their own ends but also the more general well-being of the economy as a whole.[1] Some specific points that might be stressed in electric utility advertising and that might be persuasive in getting consumers to change their energy consumption behavior so that they conserve energy and help the utility meet its goals are listed below:

1. Informing consumers of how much they could save by turning their thermostats up a few degrees in summer and down a few degrees in winter.

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[1] For example, see Shank's comments on this point on page 79 of this study.

2. Educating consumers in the savings in home heating and cooling costs which may result from proper home insulation.
3. Informing consumers of the actual operating costs of various types of electrical appliances.
4. Encouraging consumers to purchase particular brands and models of electrical appliances that are more efficient and have lower operating costs than competitive brands and models.
5. Educating the public in the possible benefits of certain practices such as staggered working hours as means to relieve power shortage problems.
6. Educating consumers in the general importance of power conservation.

This list is not meant to be complete, only suggestive of some of the ways in which electric utility advertising might be used to encourage the more efficient use of electricity.

The above discussion implies that perhaps what is needed is not the prohibition of electric utility advertising, but a reorientation of industry thinking and strategy in regard to advertising. The industry should be persuaded and perhaps compelled by regulatory commissions to employ advertising as a vehicle to motivate consumers to use electricity more intelligently rather than as a means to attempt to persuade consumers to use ever increasing quantities of electricity. There is no firm evidence to support the contention that advertising can successfully motivate consumers to change their behavior so that they use less electricity. However, it seems that the costs of such a program would be slight in relation to the possible benefits -- relief from power shortages, reduced natural resource consumption, and reduced air and water pollution. A prohibition of all electric utility advertising would eliminate all possibility of using advertising as a tool to help alleviate some of the problems it has been charged with creating.

A third implication of the study relates to the potential sales effects of the marketing efforts of electrical appliance manufacturers and retailers; and the sales effects of inefficient electrical appliances. These two factors were not considered in any significant detail in the analysis. However, it seems reasonable to suggest that they both may have a significant impact on residential electricity sales. The sheer magnitude of advertising by electrical appliance manufacturers and retailers ($800 to $1 billion in 1969), not to mention their product innovation and other promotional activities, would appear to invite some investigation by those concerned with the rapid gains in electric power consumption [48, 106, 213]. It seems strange that certain groups can be so critical of electric utility advertising and yet completely ignore similar activities by electrical appliance manufacturers and retailers. It should be noted that in 1969 the sellers of electrical appliances spent about forty times more on advertising appliances than did the entire privately owned electric utility industry [48, 106, 213].

It has been noted by at least one authority that appliance manufacturers have been more concerned with being able to maintain low sales prices on their appliances than with manufacturing appliances which operate efficiently [66, p. 34]. In other words, it has been suggested that appliances which are significantly more efficient than the average are available on the market and can be manufactured with existing technology [66, p. 34]. If all manufacturers were to commit themselves to building such appliances and if the public could be sold on the benefits of such appliances, considerable reductions in electric power consumption could be achieved.

The above discussion suggests that though electricity producers have received much of the blame for the unbridled increases in the residential demand for electricity, there is some reason to attribute at least some of the gains in residential electricity sales to the product and promotion policies of electrical appliance manufacturers. It would make little sense to prohibit electric utilities from advertising while letting electrical appliance manufacturers continue to pursue their demand stimulating activities unchecked.

In summary, three major implications for public policy makers were drawn from the study. First, the prohibition of electric utility advertising is not likely to have much effect on the residential demand for electricity. The elimination of all electric utility advertising might produce a very slight reduction in the price of electricity to residential consumers. Prohibition of sales promotional advertising, for example, would appear to be least questionable in areas presently experiencing power shortages. Second, it was argued that a total ban on all electric utility advertising may be undesirable. What is needed is a reorientation of the advertising objectives and strategies employed by electric utilities. Instead of trying to encourage more power consumption the industry might be able to direct its advertising efforts in the direction of educating consumers in the more intelligent and efficient use of electricity. Finally, it was noted that electrical appliance manufacturers devote more promotional effort to stimulating the residential demand for electricity than do electric utilities. It was also noted that appliance manufacturers have tended to sacrifice efficient and low cost appliance operation in favor of lower purchase prices. Unless something is done to change these practices by electrical appliance manufacturers constraining the promotional efforts of electric utilities will have little effect on the demand for electricity.

### Further Research

The study being somewhat exploratory in nature suggests a number of topics for further study. A few of the more promising research possibilities are listed below:

1. A study of the electricity consumption patterns of a sample of individual homes might uncover some important factors that were hidden in the aggregate data employed in this study.
2. A study of consumer knowledge about the operating costs of various electrical appliances and various other aspects of electricity consumption might serve as the basis for an educational campaign designed to eliminate consumer ignorance and misconceptions about these matters.
3. A detailed study of the advertising, product, innovation, and other promotional efforts of electrical appliance manufacturers could provide further insights into the effects of these factors on residential electricity sales.

4. Sales effects of the nonadvertising promotion of electric utilities were not formally considered in this study because there was no reasonable way to determine how much electric utilities spent on the various types of nonadvertising promotion, and no way to determine what proportions of the various types of nonadvertising promotion are directed toward the residential consumer. A total research effort might be directed toward assembling the above mentioned data by means of mail questionnaires or personal interviews directed toward electric utility executives.
5. A study might be devoted to determining the potential effects of electric utility advertising devoted to the education of consumers regarding the more efficient use of electricity. In other words, is such advertising likely to be more effective than advertising designed to stimulate sales has been.

## Limitations and Concluding Comments

The major limitations of the study were discussed in some detail in the introductory chapter. They are repeated here in summary form as follows:

1. The study is limited to the 1951-1970 period.
2. The study is limited to privately owned electric utilities, operating in the United States, with electric operating revenues of more than one million dollars.
3. Dollar advertising expenditures are used as a measure of

relative advertising effort. The acceptance of dollar advertising intensity requires several assumptions. First, the assumption that all firms employ the same media mix over time is required. Second, the assumption that all firms employ the same creative strategies is required.[1] It was noted in Chapter I that neither of these assumptions is 100 percent correct, but that there was some evidence which suggests that there is some similarity in the media mixes and creative strategies employed by electric utility firms.

4. The limitations of multiple regression as a tool of analysis are discussed in some detail in Chapter I and in Appendixes G and K.
5. The general problems encountered in attempts to measure advertising effectiveness are discussed in Appendixes D and E.
6. The use of aggregate data for the electric utility industry and for individual electric utility firms rather than data for individual households represents a limitation.
7. The use of historical data rather than data generated by controlled experiment represents a limitation in that the contaminating effects of extraneous factors cannot be accurately assessed.
8. A number of limitations in various data series were discussed. First, it was noted that the procedures used to

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[1] These two assumptions are related to the need to demonstrate that homogeneous units of advertising are being compared.

estimate per capita income in the service areas of the firms in the sample leaves those estimates subject to considerable bias. Problems with weather data were discussed as were the problems of determining how much electric utilities spend on different types of non-advertising promotion.

Certainly the study is subject to various other limitations. The ones listed above are judged to be the most important limitations. Finally, it should be noted that the results of the study can only be considered in the light of the limitations listed above.

In closing, it must be made clear that the study did not provide absolute proof of the validity of the various hypotheses. However, the weight of the evidence presented does tend to support most of the hypotheses suggested in Chapter I. The evidence also appears to support the conclusions and implications suggested in this chapter.

# APPENDIXES

# APPENDIX A

# THE ELECTRIC POWER INDUSTRY: POLLUTION, NATURAL RESOURCE CONSUMPTION AND POWER SHORTAGES

## Consumption of Natural Resources

The great increases in the residential demand for electricity, discussed in Chapter IV, have proven to be a mixed blessing for the utility industry. These sales gains have brought welcome increases in profits, but they have also brought a host of unanticipated problems. First, environmentalists and conservationists have become concerned with the increases in air and water pollution and the increases in

TABLE A-1

FOSSIL FUEL CONSUMPTION BY THE U.S. ELECTRIC UTILITY INDUSTRY (1951 and 1970)

| Fossil Fuels | Years 1951 | Years 1970 | Percent Change 1951-70 |
|---|---|---|---|
| Coal (thousands of short tons) | 105,768 | 322,357 | +204 |
| Fuel Oil (thousands of 42 gallon barrels) | 63,945 | 332,104 | +419 |
| Natural Gas (millions of cubic feet) | 763,898 | 3,894,018 | +410 |

Source: Edison Electric Institute [66, p.49] natural resource consumption that these sales gains have fostered [175, 201]. Table A-1 shows the quantities of different fossil fuels used for the generation of electricity by the total electric utility industry in 1951 and 1970.[1]

Table A-1 indicates that the increased demand for electric power has meant a great increase in the consumption of fossil fuels by the electric power industry. In 1970, the industry consumed five times more fuel oil and natural gas and three times more coal than it consumed in 1951. In 1970, the electric power industry consumed nearly 60 percent of the coal, more than 33 percent of the fuel oil, and nearly 25 percent of the natural gas produced in the U.S. [213, pp. 642, 644, 645]. These consumption rates are in excess of 1 percent of the proven reserves of each of these fossil fuels [213, pp. 642, 644, 645]. When these fossil fuel consumption rates are considered in relation to Federal Power Commission estimates of a threefold increase in the total demand for electricity between 1970 and 1990 the concern over natural resource depletion takes on real meaning [224, p. I-3-3].

## Thermal Pollution

There are two basic types of pollution associated with the generation of electricity, including: 1) thermal pollution, and 2) air pollution.[2]

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[1] Sales of total electric utility industry includes sales to residential, commercial and industrial customers by privately and publicly owned electric utilities.

[2] This discussion applies to generation by steam-electric plants. At the present time steam-electric plants account for 80 percent of all electricity generated in the U.S. [224, I-10-1].

Thermal pollution results from the use of fresh and salt water from lakes, rivers, bays, etc. to cool steam electric generators [224, I-10-1]. The Federal Power Commission has commented on the process in the following terms [224, p. I-10-1]:

> In passing through the condenser of a steam-electric plant, the cooling water is heated 10 to 30 degrees Fahrenheit, depending upon plant design. The waste heat added to the cooling water is then dissipated into the environment.

The discharge of heated water may have a number of undesirable effects on the receiving body of water. First, "the capacity of water to hold dissolved oxygen is decreased with an increase in temperature" [224, p. I-10-9]. This lowered capacity of water to hold oxygen results in ". . . a lowering of its capacity for satisfactorily assimilating organic wastes" [224, p. I-10-11]. It has also been noted that ". . . oxygen consumption of aquatic vertabrates increases with rises in temperatures up to a limiting temperature beyond which the physical exchange of oxygen in the blood is no longer possible [224, p. I-10-10]. This increased need for oxygen is coupled with the decreased ability of the water to hold oxygen at higher temperatures [224, p. I-10-10].

Second, increased temperatures in bodies of water where cooling waters from steam-electric plants are discharged present a menace to aquatic life. The following passage summarizes the major hazards to aquatic life from thermal pollution [224, p. I-10-9]:

> It is known temperatures higher than those normally experienced, particularly during summer months, can be detrimental in a variety of ways. The survival of individual organisms can be jeopardized; they may be more susceptible to disease or the effects of toxic agents; their food supply or their ability to catch food may diminish; and the inability to reproduce or to compete successfully with other organisms may indirectly eliminate a species.

The Federal Power Commission has estimated the impact of thermal pollution on the nation's water resources. The commission estimated that in 1970 the total electric utility industry used 157,000 cubic feet of water per second for cooling purposes [224, I-10-17]. Based on their estimates of the total demand for electric power in 1990, and assuming there will be no dramatic breakthrough in the technology of electric power generation between 1970 and 1990, the commission estimates the industry's water usage will more than quadruple by 1990 [224, I-10-17]. The commission estimates that in 1990 the industry will be using nearly 600,000 cubic feet of water per second for cooling purposes [224, p. I-10-17]. In rough terms, this represents a fourfold increase in thermal pollution by the industry between 1970 and 1990. The concern of the environmentalists would, again, appear to be warranted.

## Air Pollution

A second pollution problem, associated with the production of electric power from fossil fuel steam-electric plants is air pollution. According to the Federal Power Commission, "the most significant air pollutants associated with power plants are carbon monoxide, sulphur oxides, nitrogen oxides, hydrocarbons and particulate matter" [224, p. I-11-1]. Of the pollutants listed above, nitrogen oxides are perhaps the most serious because of their role in the formation of eye-irritating and vegetation-damaging photochemical smog [224, p. I-11-1].

According to the Air Pollution Control Office of the Environmental Protection Agency electric power plants account for less than 1 percent of the nation's carbon monoxide and hydrocarbon discharges, about 20 percent of both the nitrogen oxide and particulate matter discharges, and over half of the sulphur oxide discharges [224, I-11-2]. It should be noted that ". . . the concentration of energy conversion in large power plants makes the effects of [the above] pollutant emissions more serious in local areas around the plants" [224, p. I-11-1].

Of course, the industry is aware of this problem, concerned and taking steps to correct it [175, 201]. Emission control devices have been developed and are in use, companies are turning to nuclear generation, and they are using more low-sulphur coal and oil [175, 201]. However, the Federal Power Commission estimates that the annual tonnage of pollutants discharged from electric power plants will continue to increase between 1970 and 1990 because the expected increases in the demand for electricity will far outpace the industry's ability to control the emissions from its plants [224, pp. I-11-5, 6, 7].

## Power Shortages

A third problem stemming from the rapid increases in the demand for electricity is the current power shortage being experienced in certain parts of the country [175, 201]. This power shortage has been brought on by the larger than expected increases in demand and further aggravated by concern over the pollution problems discussed above [201, p. 54]. Legal action by consumer groups and governmental agencies with pollution has delayed the completion of plants and the issuance of permits for proposed plants that are desperately needed in some parts of the country [201, p. 54].

The Federal Power Commission has commented on the development of the power shortage in the late 1960's as follows [224, p. I-1-16]:

> Utility reserve margins rapidly eroded, in some cases to the point where emergency measures were required at peak load periods. In the late 1960's, the average margin fell from the 1963 level of 25 percent above the summer peak load to less than 20 percent and in some areas the reserve was much below this average. Almost -- or so it seems in retrospect -- some sections of the country were confronted with the prospect, if not the fact, of serious power shortages.

The fact that the nation is facing a relative shortage of electric power was discussed in a recent Business Week article [201, p. 54]:

> Easterners got another jolt this summer from their power companies: a wave of brownouts, blackouts, and assorted near-crises warned them once again that electricity -- the very basis of a technological society -- can no longer be taken for granted. And today, even those electric utilities that do have power to spare face the most perplexing problems in their history in trying to keep up with the soaring demand for their services.

Without going into this particular problem in more detail it seems safe to conclude the following: 1) the nation faces a power shortage; 2) this power shortage is more serious in some parts of the country, particularly the urban east, than others; 3) the problem was brought on by rapid increases in the demand for electricity; and 4) the power shortage has been further aggravated by plant construction delays resulting from the legal and political activities of conservation and environmentalist groups.

The problem discussed in this section have all tended to make it more difficult for electric utilities to justify activities designed to stimulate the demand for electric power.

# APPENDIX B

# GENERAL VERSUS SPECIAL THEORIES OF MARKETING BEHAVIOR

A number of researchers have attempted to construct generalized theories of marketing or consumer behavior. Taking different approaches to theory development, Alderson [4,5,6], Aspinwall [11], Howard and Sheth [95], Nicosia [147] and others have made significant contributions to marketing thought. However, none of these students of marketing has provided a theory of marketing or consumer behavior with generalized predictive power [86].

Recent years have witnessed important advances in marketing science [96]. First, there has been a great increase in the application of quantitative methods to marketing phenomena [121,126]. Green [81,82,83,84], Kotler [116], Palda [152], Lazer [121] and Buzzel and Slater [38] have made major contributions in the development of quantitative marketing. Second, there have also been advances in the application of behavioral science theories to marketing problems [96]. Major contributions in this area have been made by Bliss [29], Engel et al. [67], Howard and Sheth [95], McNeal [135], Myers and Reynolds [146] and Nicosia [147]. Finally, and most importantly, a blending of these two types of approaches to marketing problems -- behavioral and quantitative -- seems to have taken place. Darden [58], Howard [96], and Lazer [121] have noted this synthesis and John Howard [96, p. 21] refers to it as the "...new marketing technology." Studies by Day [59], Ronald Howard [97], Robertson and Kennedy [165], and Stoezel [197] illustrate the application of this new marketing technology. The hypotheses and theoretical basis of these studies are rooted in the behavioral sciences while sophisticated statistical methods are used in data analysis.

All this sophisticated theorizing and all these powerful mathematical and statistical methods have failed to provide a general theory of marketing [63, 86]. For example, in 1969 Howard and Sheth published a book entitled The Theory of Buyer Behavior [95]. In 1971 the results of an attempt to validate their theory, using simultaneous equation multiple regression models, were published in the Journal of Marketing Research [70]. These results showed that the Howard and Sheth model of buyer behavior does not have the generalized predictive power that its authors claim.

In a recent article, Martin Shubik made the following observations [183, p. 407]:

> With a reasonable amount of luck an important lesson from the false starts in general economic theorizing can be learned. Instead of looking for a general theory of welfare economics, or a theory of oliogolpoly, etc., there should be a greater stress on special theories which may be of limited scope but with considerable application.

Although Shubik's comments are directed toward his fellow economists, they might be appropriate to marketing theorists as well.

It has been suggested by Garfield and Lovejoy [76, p. 1], Kolb [115, p. 329], McKie [134, p. 6] and others that electric utilities constitute a separate business category, that they have certain characteristics that distinguish them from all other types of businesses. Garfield and Lovejoy provide a list of these distinguishing characteristics as follows [76, p. 1]:

1. Utilities operate as monopolies with government approval.
2. Electric utilities supply a service which for some users has no close substitutes.
3. Electric utilities are subject to public regulation of their prices and profits.
4. Electric utilities must serve every financially responsible customer in their service areas, at reasonable rates, and without unjust discrimination.
5. A public utility may not enter a new market (area), or abandon an existing market without the consent of public authority.
6. Finally, public utilities generally are granted by law the power of eminent domain. This power permits the utility to force, through court action if necessary, the sale of private property which it may need to serve the public.

These constraints and powers which distinguish utilities from other types of businesses provide some basis for considering them as a special business category that will never fit into a general theory of marketing behavior. These unique constraints and powers also provide some basis for arguing that electric utilities warrant some special theoretical treatment in regard to their marketing activities.

# APPENDIX C

# SELECTING THE APPROPRIATE STATISTICAL TOOLS FOR DATA ANALYSIS

Three articles, two by Sheth [180,181] and one by Kinnear and Taylor [113], have provided a very neat decision framework to aid the researcher in deciding which type of multivariate analysis is most appropriate to the study of a particular phenomena. More specifically, these articles provide flowcharts which through a series of decision points lead the researcher to the appropriate mode of analysis.

## Statistical Techniques Considered

Alternative multivariate techniques considered in the Sheth articles are listed below [181, p. 15]:

1. Multiple regression
2. Multiple discriminant analysis
3. Multivariate analysis of variance
4. Canonical analysis
5. Factor analysis
6. Cluster analysis
7. Metric multidimensional scaling
8. Nonmetric scaling
9. Latent structure analysis

An expanded list of techniques is considered in the more recent Kinnear and Taylor article. These are listed below [113, p. 57]:

1. Multiple classification analysis
2. Multiple discriminant analysis
3. Automatic interaction detector
4. Dummy variable multiple regression
5. Multiple regression
6. Canonical analysis
7. Multivariate analysis of variance
8. Nonmetric multidimensional scaling
9. Latent structure analysis
10. Nonmetric cluster analysis
11. Nonmetric factor analysis
12. Metric cluster analysis
13. Metric factor analysis
14. Metric multidimensional scaling
15. Nonmetric multidimensional scaling
16. Latent structure analysis
17. Nonmetric cluster analysis
18. Nonmetric factor analysis

Sheth's scheme for selecting the appropriate multivariate technique is shown in Figure C-1. The more comprehensive scheme provided by Kinnear and Taylor is shown in Figure C-2.

## The Kinnear and Taylor Scheme

Since the Kinnear article was written in response to Sheth's article and points out some weaknesses in Sheth's scheme the Kinnear

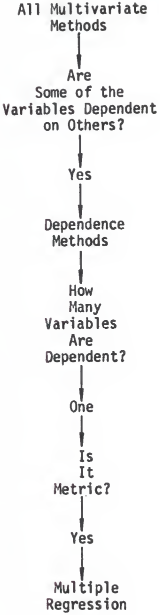

FIGURE C-1

SHETH'S SCHEME

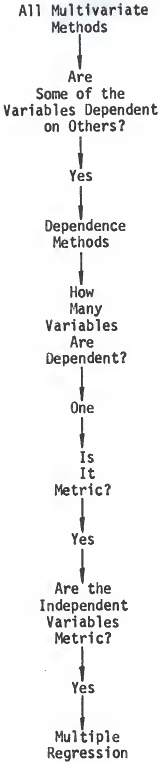
All Multivariate Methods
Are Some of the Variables Dependent on Others?
Yes
Dependence Methods
How Many Variables Are Dependent?
One
Is It Metric?
Yes
Are the Independent Variables Metric?
Yes
Multiple Regression

FIGURE C-2

THE KINNEAR AND TAYLOR SCHEME

approach will be used here. According to this approach the researcher must first ask himself whether some of the variables in his model are dependent upon other variables in his model. In the case of the model suggested earlier in this chapter, the answer is yes. Per capita residential sales were hypothesized to be determined or dependent upon a number of variables. The yes answer to the above question leads the researcher to that broad category of multivariate techniques known as dependence methods.

The next question relates to how many variables are dependent. The answer is one -- per capita residential sales of electricity. The next question asks if it (the lone dependent variable) is metric.

The term metric requires some clarification. Basically it refers to the way the data is scaled. According to Green there are four basic types of data scales [84, p. 222].

1. Nominal scales -- Scales in which numbers ". . . serve only as labels or tags for identifying objects, properties or events. For example, we can assign numbers to baseball players or television subscribers" [84, p. 177]. It is meaningless to perform any sort of arithmatical operations on data scaled in this manner [133, p. 518].
2. Ordinal scales -- These are ranking scales [123, p. 519]. An example would be the ranking of colas according to taste. If the number one is assigned to the highest ranking cola, the number two to the second highest ranking cola, and so on, an ordinal scale is derived. It is important to note that ranking of the brands according to taste does not provide any basis for assessing the

differences among colas in regard to taste [193]. Number one and number two might be almost identical in taste while three is off in a class by itself.

In the case of ordinal scales ". . . statistical description is limited to positional measures like the median, quartile, percentile or other summary statistics which deal with order among entities. The usual arithmatic operations cannot be performed with ranked data" [84, p. 178].

d. Interval scales -- These are scales that have equal intervals but arbitrary zero points [123, p. 519]. Good examples of interval scales are the Fahrenheit and Centigrade scales used to measure temperature. Each scale has an arbitrary zero point ". . . and equal temperature differences are found by scaling equal volumes of expansion in the liquid used in the thermometer. Interval scales permit inferences to be made about the differences between the entities to be measured, but we cannot say that any value on a specific interval scale is a multiple of another" [84, p. 179]. Most statistical measures -- arithmatic mean, standard deviation, correlation coefficient, regression coefficient, coefficient of determination, etc. -- require only interval scaled input data for their computation [181, p. 14].

4. Ratio scales -- All arithmatic operations can be performed on ratio scaled data [84, p. 180]. A ratio scale is identical to an interval scale with the exception that

> the ratio scale has a true zero point [123, p. 520]. Ratio scales derive their ". . . value from the fact that the ratio of any two values is independent of the units in which they are measured" [123, p. 520]. Examples of ratio scales are scales for measuring length, weight, sales, etc. [84, p. 180].

Green suggests that a fifth type of scale, a hybrid, might be added to the four discussed above [84, p. 222]. This fifth type of scale is a metric scale and as a minimum it falls somewhere between ordinal and interval scales [83, p. 8]. Without taking a long digression on this point, a scale is generally considered to be metric if it is interval or ratio scaled and nonmetric if it is nominal or ordinal scaled [181, p. 15].

All data being considered for this project are at least interval scaled and most are ratio scaled. Therefore, all data under consideration is metric and the answer to the question of whether the dependent variable is metric is yes.

The next question asks whether the independent variables are metric. The answer to this question is yes, all the independent variables are metric.

This last answer leads to multiple regression as the appropriate type of analysis for the particular problem at hand.

Use of multiple regression to measure advertising effectiveness is well documented in the marketing literature. Articles by Bass [20], Blattberg and Stivers [28], Buzzell [39], Echelberger and Elwood [65], Hughes [98], Luck et al. [130], Palda [152], Quandt [160], Sexton [176], Simon [184, 185], Tull [205], and Twedt and Knitter [207] provide authority for the use of multiple regression in measuring advertising effectiveness. It is not suggested that the use of multiple regression to measure the effects of advertising is without problems, only that it is a reasonable approach to the problem. Specific problems encountered when using multiple regression to measure advertising effectiveness will be discussed in Chapters IV and V. The regression analysis will be supplemented with other less formalized procedures where appropriate.

# APPENDIX D

## THE MEASUREMENT OF ADVERTISING EFFECTIVENESS

Peter Doyle must have been referring to the quality of advertising research rather than to its quantity when he made the following statement [63, p. 571]:

> In spite of the interest in advertising, research in the field has not been very impressive. This is partly because of the lack of a well-developed theory of marketing and advertising.

No topic in marketing has received greater attention from academicians, none generates greater interest among marketing practicioners than the measurement of advertising effectiveness.

But what is meant by the term advertising effectiveness? Dalbey, Gross, and Wind, in a book sponsored by the Marketing Science Institute, have provided the following definition of advertising effectiveness [57, p. 6]:

> The term is used to denote the degree to which advertising can change people's external or internal behavior with respect to an item -- product or idea -- advertised, and in the direction desired by the advertiser.

Studying the published research on the topic one finds that the various approaches to the measurement of advertising effectiveness fall into one of two categories -- experimental or nonexperimental design -- depending upon the research methodology used [57, p. 10]. The nonexperimental approach involves, for example, the use of historical data ". . . for the purpose of trying to determine how expenditures apparently have affected company sales" [57, p. 10]. Palda's [152] analysis of Lydia Pinkham advertising and sales data using multiple regression and Tull's [205] research on the carry-over effects of advertising are good examples of the nonexperimental approach. Numerous other examples of nonexperimental research on advertising effectiveness have been published in recent years [20, 28, 39, 40, 98, 100, 119, 176, 185, 230, 244].

Schreier has defined experiments in the following terms [171, p. 42]:

> It is characteristic in an experiment to create a situation artificially and then to study by observation or questioning, how people behave in it, how they feel in it. We expose people to an artificial stimulus and study how they react to it.

Schreier [171, p. 43] goes on to discuss four types of experiments in marketing:

1. Offering the real stimulus (a product, a package, an advertisement) and studying the actual reaction of the subjects exposed to it. Sales tests are the outstanding examples of this type.
2. Offering the real stimulus but asking the subjects how they would react rather than observing how they do react.
3. Showing models or pictures of product and studying whether the subjects buy or order the product.
4. Showing a model or picture of a product and asking whether the subject would buy it if it were available.[1]

---

[1] Schreier notes that types two and four above should be referred to as quasi-experiments because they require questioning as opposed to experimentation [171, p. 43].

A number of experimental approaches to the measurement of advertising effectiveness have been advanced in the literature [2, 18, 37, 47, 50, 81, 92, 119, 174, 197, 230].

However, this impressive array of research -- experimental and nonexperimental -- has failed to provide any generally applicable approach that gives an unambiguous measure of advertising effectiveness [57, 63]. Some approaches work well in some situations but not in others [57, p. 1]. Sometimes the commitment of time and money required to arrive at some measure of advertising effectiveness may be far greater than any conceivable benefits that such a measure can provide to the firm [50, p. 110]. Progress has been made in the development of techniques to measure advertising effectiveness but no one has provided a general solution to this marketing problem [63, 86, 96].

## APPENDIX E

## HOW ADVERTISING WORKS

There is no empirical evidence that advertising by electric utilities has any effect on the demand for electricity. However, numerous a priori judgments as to the potential effects of advertising on the residential demand for utility services were found in the literature.

One of the earliest writers on utility advertising expressed a very optimistic and positive attitude toward advertising by public utilities in the following passage [111, pp. 46, 47]:

> A public utility company should be a liberal advertiser, because of the benefits it will derive from attracting attention to the advantages of using the commodity in which the utility is directly interested.

Numerous modern authors have suggested that advertising enables utilities to increase the demand for their services [35, 76, 94, 103, 110, 118, 157, 162, 242, 244, 245]. However, none of these authors provides solid evidence to support this contention.

At least one writer has suggested that in recent years advertising by electric utilities may have had negative effects on the demand for their services [103, p. 41]:

> Such advertising themes as "flameless heating," the flame is going out," "electric heat sweeps the nation," etc., are properly described as aggressive and questionable for a regulated quasi-monopoly enterprise. Unbiased studies of the effectiveness of such advertising reveal the public is adversely

> affected, unbelieving, and offended by such copy. Yet, such costs are part of the burden on existing monopoly bound customers.

Though this author says that studies of electric utility advertising show that the public is adversely affected, he does not cite any specific studies to back up this contention.

Given the differing opinions and the paucity of hard evidence on the effects of electric utility advertising, it seems appropriate to consider some of the theories of how advertising works to affect the behavior of individual consumers.

If there is any generally accepted theory of how advertising works it would have to be that consumers go through a ". . . hierarchal sequence of effects, resulting from the perception of an advertisement, which moves the consumer ever closer to purchase" [153, p. 13]. This basic idea has been accepted in advertising circles for some time [89, p. 149]. There is, however, considerable disagreement about the specific sequence of effects that consumers go through.

Heidingsfield and Blankenship have suggested that if advertising is to be effective it must first capture the consumer's attention, then it must get his interest, next it must build some desire to own the product, and finally it must prompt the consumer to take action -- to buy the product [89, p. 149]. Coley has suggested a sequence of effects, including: awareness, comprehension, conviction and action [49, p. 55]. Sandage and Fryburger have suggested a sequence of effects, including: attention, interest, desire, belief and conviction, action and satisfaction [170, p. 260]. Wolfe, et al. have suggested a sequence of effects, including: awareness, acceptance, preference, intention to buy and provocation of sale [241]. Finally, Lavidge and Steiner have suggested a sequence of effects, including: awareness, knowledge, liking, preference, conviction, purchase [120]. These are some of the views of the internal psychological processes a particular consumer is supposed to experience from the perception of an advertisement to purchase. It should be noted that the Lavidge and Steiner hypothesis has received empirical support in studies by Palda [153] and O'Brien [148].

All of the researchers cited above agree that to be effective an advertisement must first get attention and ultimately prompt a purchase. At first inspection there appears to be some disagreement about what happens in between these two extremes. However, closer scrutiny and reference to the cited works indicates that these differences may be largely a question of semantics. It seems that these authors see roughly the same things happening between attention and purchase, but that they use different names for these same things.

The point of this discussion is that to be effective advertising must have some effect on the consciousness and behavior of individual consumers. This fact is sometimes forgotten in macro studies of advertising effectiveness. It follows from this discussion that one way to study the effectiveness of utility advertising would be to observe, or try to determine through interviews, or experiments, the response of individual consumers to specific utility advertisements. This approach has several advantages. First, it opens the possibility of measuring other effects in addition to sales effects. For example, one might try to determine how successful a particular advertisement had been in getting attention, developing interest, or generating desire for the product. Second, this approach permits the researcher to take into account the fact that it may take time for a particular advertising campaign to have any effect on sales [100, 152, 153]. Finally, this approach is compelling because it focuses on the psychological impact of a particular advertisement on a particular consumer.

This approach also has several serious drawbacks. First, the researcher is confronted with severe measurement problems whenever he tries to draw inferences from observations of consumers or whenever he asks consumers to report on their behavior [117, pp. 88-92]. Second, the high costs involved in interviewing or observing individual consumers tends to limit the size of the samples employed and, thus, the reliability of the conclusions drawn from such studies [132, p. 105]. As a practical matter, this researcher did not have the resources to pursue such a study even if it had been deemed appropriate.

Since this investigation is concerned with the relationship between utility advertising and the residential demand for electricity over time and between firms, the only reasonable way to approach the problem was at the industry and individual firm levels. It is still important to remember, while constructing the model that advertising must ultimately affect the behavior of individual consumers. The psychological states that a consumer goes through from exposure to an advertisement to purchase of the advertised product are not of primary interest here, only the impact of advertising on sales.

# APPENDIX F

## ELECTRIC UTILITY PROMOTIONAL ACTIVITIES DEFINED

Electric utilities report their promotional expenditures by four broad categories, including: supervision, demonstrating and selling expenses, advertising expenses, and miscellaneous selling expenses. The specific promotional activities included under each of these headings are discussed below:

The passage below defines those expenditures which are included under the supervision category [226, pp. 101-189].

> This account supervision shall include the cost of labor and expenses incurred in the general direction and supervision of sales activities. Direct supervision of a specific activity, such as demonstrating, selling, or advertising shall be charged to the account wherein the costs of such activity are included.

The account demonstrating and selling expenses includes ". . . the cost of labor, materials used and expenses incurred in promotional demonstrating and selling activities the object of which is to promote or retain the use of utility services by present and prospective customers" [226, pp. 101-189].

The following specific expense items are included in demonstrating and selling expense category [226, pp. 101-189]:

1. Demonstrating uses of utility services.
2. Conducting cooking schools, preparing recipes, and related home service activities.

3. Exhibitions, displays, lectures and other programs designed to promote use of utility services.
4. Experimental and development work in connection with new, improved appliances and equipment, prior to general public acceptance.
5. Solicitation of new customers or of additional business from old customers, including commissions paid employees.
6. Engineering and technical advice to present to prospective customers in connection with promoting or retaining the use of utility services.
7. Special customer canvasses when their primary purpose is the retention of business or the promotion of new business.
8. Supplies and expenses pertaining to demonstration, experimental and development activities.
9. Booth and temporary space rental.
10. Loss in value on equipment and appliances used for demonstration purposes.
11. Transportation, meals and incidental expenses.

Under the heading advertising expenses utilities report ". . . the cost of labor materials used and expenses incurred in advertising designed to promote or retain the use of utility service" [226, pp. 101-90]. The following specific items are included under this category [226, p. 101-90]:

1. Direct supervision of advertising department.
2. Preparing advertising material for newspapers, periodicals, billboards, and preparing and conducting motion

pictures, radio and television programs.

3. Preparing booklets, bulletins, etc., used in direct mail advertising.
4. Preparing window and other displays.
5. Clerical and stenographic work in connection with advertising department.
6. Investigating advertising agencies and media and conducting negotiations in connection with the placement and subject matter of sales advertising.
7. Advertising space in newspapers, periodicals, billboards, radio, etc., for sales promotion purposes.
8. Materials and services given as prizes or otherwise in connection with civic lighting contests, bazaars, etc., in order to publicize and promote the use of utility services.
9. Fees and expenses of advertising agencies and commercial artists.
10. Novelties for general distribution.
11. Postage on direct mail advertising.
12. Premiums distributed generally, such as recipe books, etc.
13. Printing booklets, dodgers, bulletins, etc.
14. Supplies and expenses in preparing advertising materials.
15. Office supplies and expenses.

The fourth major sales expense category, miscellaneous sales expenses, includes ". . . the cost of labor, materials used and expenses incurred in connection with sales activities which are not includible in other sales expense accounts" [226, p. 101-91].

# APPENDIX G
# PROBLEMS ENCOUNTERED IN THE APPLICATION OF MULTIPLE REGRESSION TO TIME-SERIES DATA

The time-series analysis was approached with some trepidation. Two problems, often encountered in time-series analysis using aggregate data, were anticipated [202, pp. 556-573].

## Autocorrelation of Errors

According to Kane, ". . . regression models fitted to economic time-series data almost always evidence some degree of stochastic dependence between successive values of the error term" [107, pp. 359-360]. Reasons for the presence of autocorrelation in aggregate time-series data are discussed in the following passage [107, p. 360]:

> First, effects due to particular chance disturbances (strikes, military actions, droughts, etc.) or omitted variables tend to persist through several data collection periods. If the effect of any such factor is positive for the j th observation, odds are that it will be positive for the (j + 1) st observation also. Second, methods of data collection and reporting generally incorporate elements of smoothing and interpolation which average "true" disturbances over adjacent periods.

One of the crucial assumptions of least squares regression is that successive values of the error term (u) are not correlated [102, p. 243]. The existence of autocorrelation (successive dependence of the error terms), thus, presents some serious problems for the researcher using regression analysis. Autocorrelation in a data series biases the estimates of the standard deviations of the regression coefficients [202, p. 256]. Where autocorrelation is positive, which is the typical case with time-series data, conventional formulas underestimate the standard deviations of the constant term (a), the regression coefficients (B's), and the error terms (u) [107, pp. 361-362]. This bias may lead the researcher to make serious errors such as accepting the hypothesis that there is a relationship between two variables $(B > 0)$ when in fact there is no relationship [107, p. 362].

To detect the presence of autocorrelation in the time-series utility industry data, the Fortran IV program written for this study was expanded to include computation of the Durbin-Watson "d" statistic [64, pp. 159-178]. The Durbin-Watson "d" statistic provides a statistical measure of the randomness of the error term (u) for a particular regression [202, pp. 199-200]. The formula for computing the "d" statistic is as follows [64]:

$$d = \frac{\sum_{t=2}^{n} (e_t - e_{t-1})}{\sum_{t=1}^{n} e_t}$$

where:

e = error term

t = time

d = Durbin-Watson statistic

Durbin and Watson established upper $(d_u)$ and lower $(d_L)$ limits for their "d" statistic. These limits permit the researcher to test the hypothesis of zero autocorrelation against the opposite hypothesis of positive autocorrelation. The following relationships were established by Durbin and Watson [64]:

> If $d < d_L$, reject the hypothesis that the series is not autocorrelated.
>
> If $d > d_u$, do not reject the null hypothesis.
>
> If $d_L > d > d_u$ the test is inconclusive.

The $d_L$ and $d_u$ values are found by consulting a table while d is the computed "d" statistic. The values of $d_L$ and $d_u$ depend upon the number of observations the researcher has, the number of explanatory (independent) variables in the model, and the level of confidence with which the researcher wishes to test the null hypothesis [102, p. 430].

## Multicollinearity of the Data

A second problem often encountered in multiple regression time-series analysis is that of multicollinearity [202, pp. 147-155]. Johnston has noted that ". . . one of the basic assumptions of the linear model [least-squares regression] is that no linear dependence exists between the explanatory variables" [102, p. 160]. Multicollinearity is a condition where two or more of the independent variables are highly correlated [84, p. 363].

Johnston has discussed three consequences of multicollinearity [102, p. 160]:

> The precision of estimation falls so that it becomes very difficult, if not impossible, to disentangle the relative influence of the various independent variables.
>
> Investigators are sometimes led to drop variables incorrectly from the analysis because their coefficients are not significantly different from zero, but the true situation may be not that a variable has no effect, but simple that the set of sample data has not enabled us to pick it up.
>
> Estimates of coefficients become very sensitive to particular sets of sample data, and the addition of a few more observations can sometimes produce dramatic shifts in some of the coefficients.

The detection of multicollinearity is not quite as objective as is the detection of autocorrelation. Johnston recommends that the researcher examine the simple correlations or coefficients of determination for all the possible pairs of independent variables in the particular model [102, p. 163]. If this analysis shows a high correlation between one or more pairs of independent variables then multicollinearity is certainly present [102, p. 163].

# APPENDIX H

## DESCRIPTION OF DATA SERIES EMPLOYED IN THE TIME-SERIES ANALYSIS

Data sources and data estimation procedures for the time-series analysis are discussed in this appendix.

Kilowatt hour sales per customer -- This series was calculated by dividing total residential kilowatt hour sales for the privately owned electric utility industry by the total number of residential customers for this industry. The sales and number of customer data were obtained from the Federal Power Commission's *Statistics of Privately Owned Electric Utilities* [222].

Price of electricity -- In Chapter III it was argued that an average price is not a very good measure of electricity price because all electric utilities have steps in their rate schedules. Because of these steps, the average price per kilowatt hour paid by a given consumer depends on his monthly kilowatt hour consumption. For this reason, the price of 250 kilowatt hours was chosen as the best measure of electricity price. This quantity represents the average monthly consumption of electricity by residential customers in the middle years of the 1951-1970 period. Price data were obtained from Edison Electric Institute's *Statistical Yearbook* [66]. This series was adjusted for inflation using Bureau of Labor Statistics electricity price index data [66].

Advertising expenditures per residential customer -- This series was computed by dividing the aggregate advertising expenditures of privately owned electric utilities by the total number of residential customers they serve. Advertising and residential customer data were obtained from Statistics of Privately Owned Electric Utilities [222]. This series was adjusted for inflation using the implicit gross national product deflator [217]. Dollar advertising expenditures were adjusted for inflation so that they would reflect the decreased amount of advertising that a dollar will buy. There is no specific price index for advertising services. The consumer price index did not seem appropriate because it reflects the prices of consumer goods only. The gross national product deflator was used to adjust the series because it reflects a broader range of prices.

Consumer Income -- The family is the basic consuming unit for electricity. It, therefore, seems that median family income is the most appropriate measure of income for use in this model of the determinants of the residential demand for electricity. Median family income data were obtained from Bureau of the Census publications [212]. The raw median family income data were adjusted for inflation using the Bureau of Labor Statistics', Consumer Price Index [216].

Weather conditions -- The time series investigation is based on aggregate data for the entire privately owned electric utility industry. Geographically this industry is spread over the entire United States. There is no measure that characterizes the climate of the entire country in any meaningful way. No measure of weather was included in the time series model.

Stock of appliances -- An index was developed to represent the per customer stock of electrical appliances. This index was based on the per customer ownership of the four highest power consuming appliances. These appliances and their average annual kilowatt hour consumption are shown in Table H-1. The per customer ownership figures for these different appliances were weighted by the relative power usage rates for the different appliances as expressed by the percentages in Table H-1. The per customer ownership figures for the four appliances, weighted by each appliance's relative power usage, were then summed to provide an appliance stock index. This index has a lower limit of zero (if per customer ownership of each of the four appliances is equal to one). Appliance ownership data were obtained from Merchandising Week [189].

## TABLE H-1

## AVERAGE ANNUAL KILOWATT HOUR USAGE FOR THE FOUR HIGHEST POWER CONSUMING APPLIANCES

| Appliance | Annual Kilowatt Hour Usage | Percent of Total Usage For The Group |
|---|---|---|
| Water Heaters | 4219 | 52.9 |
| Air Conditioners (Room) | 1389 | 17.4 |
| Home Freezers | 1195 | 15.0 |
| Electric Ranges | 1175 | 14.7 |

Source: Federal Power Commission [224]

# APPENDIX I

# POSSIBLE LAGGED AND CUMULATIVE EFFECTS OF ELECTRIC UTILITY ADVERTISING

It was implicitly assumed in the specification of the time-series model that the sales effects of advertising all take place in the period during which that advertising was run and that the effects of advertising do not accumulate from period to period. There is some basis to argue that these are not realistic assumptions. The discussion of how advertising works (see Appendix E) suggested two things about the relationship between advertising and time: 1) it may take a series of advertisements to break through a threshold of buying resistance (cumulative effect); 2) a given purchase may have had its origin in some long forgotten advertisement (lagged effect).

## Alternative Specifications of the Lagged and Cumulative Effects of Advertising

The existence of these effects has been discussed in theoretical terms by Jastram [100] and evaluated empirically by Palda [152,153,154]. The time series model of the determinants of electricity demand was respecified to test for the existence of lagged and cumulative advertising effects. First, the possibility of a one period lagged effect was considered, as follows:

$$S/C = a + B_1P_2 + B_2P_4\ (t-1) + B_3Y + B_4A + u$$

where:

$S/C$ = per customer kilowatt hour sales

$P_2$ = price of 250 kilowatt hours (adjusted for inflation)

$P_4$ = per customer advertising expenditures (adjusted for inflation)

$Y$ = median family income (adjusted for inflation)

$A$ = per customer appliance stock index

$a$ = constant term

$B_{1-4}$ = regression coefficients associated with the respective independent variables

$u$ = unknown, random error term

$t$ = time

Second, the possibility that utility advertising expenditures have a cumulative effect but no lagged effect was considered using the following model:

$$S/C = a + B_1P_2 + B_2P_4 \text{ (CUMULATIVE)} + B_3Y + B_4A + u$$

where:

$S/C$, $P_2$, $P_4$, $Y$, $A$, $a$, $B_{1-4}$, $u$ are as defined previously

CUMULATIVE refers to the specification that sales in period t are a function of cumulative advertising expenditures, including those in the present period

Finally, the hypothesis that the effects of utility advertising are cumulative, but lagged one period, was tested using the following model:

$$S/C = a + B_1P_2 + B_2P_4 \text{ (CUMULATIVE--LAGGED ONE PERIOD)} + B_3Y + B_4A + u$$

where:

$S/C$, $P_2$, $P_4$, $Y$, $A$, $a$, $B_{1-4}$, $u$ are as defined previously

CUMULATIVE--LAGGED ONE PERIOD refers to the specification that sales in period t are a function of cumulative advertising expenditures through period t-1

## Results with Lagged and Cumulative Effect Models

The multiple regression results obtained using the three alternative specifications of the original time series model are summarized in Table H-1.

None of the results obtained with the respecified versions of the original model, shown in Table H-1, are superior to those obtained with the original model. It should be noted that the three lagged and cumulative effect models do not exhaust the almost infinite number of possible ways advertising expenditures might be lagged or accumulated.

The coefficients of multiple determination are high for all the lagged and cumulative effect models. However, the regression coefficients associated with per customer advertising expenditures are negative in all cases. The regression coefficients associated with price are statistically insignificant in all cases and the regression coefficients associated with the advertising and income variables fail to reach statistical significance in the cumulative effect, no lag and cumulative effect, one period lag versions of the model.

The simple correlations between the variables in each of the lagged and cumulative effect versions of the model are not shown. These correlactions were computed and show that each of the three versions of the model suffer from serious multicollinearity. The computed Durbin-Watson statistics show that the cumulative effect, no lag and cumulative effect, one period lag versions of the model also suffer from autocorrelation.

## TABLE I-1

## MULTIPLE REGRESSION RESULTS OBTAINED WITH VARYING SPECIFICATIONS OF THE LAGGED AND CUMULATIVE EFFECT OF UTILITY ADVERTISING

| | Results Assuming One Period Lag | Results Assuming Cumulative Effect, No Lag | Results Assuming Cumulative Effect and One Period Lag |
|---|---|---|---|
| a (Constant | 1934.96 | 7561.78 | 4141.93 |
| $B_1$ (Price) | - 405.05 | - 1142.27 | - 760.12 |
| $B_2$ (Advertising) | - 2241.87* | - 56.62 | - 80.56 |
| $B_3$ (Income) | .74* | .24 | .32 |
| $B_4$ (Appliance Stock) | 10919.91* | 14459.15* | 15737.83* |
| $R_2$ (Coefficient of Multiple Determination) | .994** | .989** | .990** |
| D (Durbin-Watson) | 1.667*** | .660**** | .714**** |

*Significant at the .01 level (t test)
**Significant at the .01 level (F test)
***In the range of indeterminacy, cannot accept or reject the hypothesis of zero autocorrelation at the .01 level
****Indicates the existence of positive autocorrelation with 99 percent confidence

## Failure to Discern Lagged or Cumulative Effects

The fact that no lagged or cumulative advertising effects could be clearly discerned in the above analysis does not mean that such effects do not exist. It does mean that if utility advertising does work with some wort of lagged or cumulative effect the data series or mode of analysis employed did not reveal these effects.

The multicollinearity and autocorrelation in the data series are possible explanations for the failure of the model to clearly show the existence of lagged and cumulative advertising effects [102, p.160].

There is some reason to question the importance of lagged and cumulative effects in the case of electric utility advertising. There is also some reason to question whether these effects can be measured in the case of electric utility advertising. The only empirical evidence that advertising does have a delayed effect was provided by Palda in his study of the Lydia E. Pinkham Medicine Company [152,153]. Palda noted that he was able to measure the cumulative and lagged effects of Pinkham's advertising because the company spent a high proportion of sales revenues (40 to 60 percent) on advertising and because the proportion spent varied significantly from period to period [152, p. 167]. Neither of these conditions hold true for electric utility firms.

In 1969 the average privately owned electric utility spent slightly more than 1 percent of its revenues from residential sales on advertising [222, p. XXXVI]. Second, privately owned electric utilities are remarkably consistent in regard to their level of expenditures on advertising. Over the 1951-1970 period, firms in the industry spent approximately 1 percent of revenues from residential sales on advertising in every year [222, p. XXXVI]. Palda suggests that when advertising expenditures are not large, in relation to sales, the effects of advertising are not so large and are more difficult to detect through analysis of historical data [152, p. 167].

Palda also suggests that when advertising expenditures are relatively stable from year to year it is reasonable to ignore the lagged effect of advertising [152, p. 167]. This conclusion is based on Palda's cumulative lag theory which can be summarized as follows:

1. Advertising expenditures can be considered to be investments in goodwill [152, p. 163].
2. This pool of goodwill is increased each year by the amount of advertising expenditures in the particular year [152, p. 164].
3. The pool also depreciates each year [152, p. 165]. This depreciation is due to the memory losses of consumers, changing consumer habits, the action of competitors, etc. [152, p. 165].

Palda has noted that this pool of goodwill can be ". . . viewed as capital accumulated up to the beginning of the current period, suitably depreciated over this period, and compromising this period's advertising expenditures as well" [152, p. 165]. If additions are nearly equal to depreciation, the pool of goodwill does not change much in size. It might be argued that electric utilities have a relatively constant pool of goodwill because their advertising expenditures have been almost constant in relative terms over the last 20 years. On the basis of the above discussion it is suggested that the lagged effect may not be particularly important in the case of electric utility advertising and that current expenditures might serve as a rough measure of the pool of advertising goodwill affecting the sales of electric utilities.

# APPENDIX J

## DESCRIPTION OF THE SAMPLE

The population of interest was defined earlier to include the 212 privately owned class A and B electric utilities which operate in the United States. These 212 privately owned electric utilities can be divided into groups based on the types of energy they sell. Firms that sell electricity only are referred to as straight electric utilities while firms selling both electricity and natural gas are referred to as combination utilities [34, p. 688]. In 1969 there were 78 combination and 134 straight electric privately owned, class A and B electric utilities in the United States.

Division of the universe into combination and straight electric utilities is based on the idea that these categories represent two distinct subgroups of the total privately owned electric power industry. In an empirical study, Brandon found several significant differences between the market behavior of combination and straight electric utilities. These differences are summarized below [34, pp. 702-703]:

> The statistical results described in this paper all support the theory that combination utilities enjoy greater market power than separated gas and electric [straight electric] companies -- in spite of regulation. Combinations earn higher rates of return from their electric operations than do straight electrics, they spend less on promotions, have higher average costs although possibly lower average cost curves, obtain higher average revenue from all three categories of customer, either charge higher marginal rates or provide poorer quality of service, and induce less consumption of electric energy.

After the universe was partitioned into straight electric and combination utility subgroups a number of individual utility firms were eliminated from the population because they operated entirely outside the continental United States[1] or because they had no residential customers, or because they were not operating companies. After these subtractions were made 78 combination and 105 straight electric utilities remained. A random sample including 39 combination and 52 straight electric utilities was drawn from this universe. This sample included one-half of both the combination and straight electric utilities. Practical consideration -- unavailability of certain data -- forced the elimination of 11 combination and 19 straight electric utilities from the original sample. The sample finally employed in this study included 28 combination and 33 straight electric firms. This sample, due to the deletions mentioned above, is not a random sample. It does seem reasonable to argue that the sample is representative of the industry. Deletions from the original population and original sample are summarized in Table J-1.

A list of the specific straight electric firms included in the sample is provided in Table J-2. The geographic areas served by these utilities are described in Table J-3. The same information for the combination utility sample is provided in Table J-4 and Table J-5.

---

[1] This condition presented problems in regard to the availability of certain important data.

## TABLE J-1

## SUMMARY OF DELETIONS FROM THE ORIGINAL POPULATION

| | Combination Utilities | Straight Electric Utilities |
|---|---|---|
| Total Number | 78 | 134 |
| Operate outside continental U. S. | 0 | 4 |
| Non operating companies | 0 | 3 |
| No residential customers | 0 | 22 |
| Number remaining | 78 | 105 |
| Number in original sample | 39 | 52 |
| Number for which some critical data were not available | 11 | 19 |
| Number in final sample | 28 | 33 |

Source: Federal Power Commission [222]

## TABLE J-2

## STRAIGHT ELECTRIC UTILITIES IN FINAL SAMPLE

| Company Number | Company Name |
|---|---|
| 1 | Arkansas Power & Light |
| 2 | Florida Power & Light |
| 3 | Florida Power |
| 4 | Gulf Power |
| 5 | Tampa Electric |
| 6 | Idaho Power |
| 7 | Commonwealth Edison |
| 8 | Indiana & Michigan Power |
| 9 | Public Service Indiana |
| 10 | Kansas Gas & Electric |
| 11 | Louisiana Power & Light |
| 12 | Central Maine Power |
| 13 | Boston Edison |
| 14 | Detroit Edison |
| 15 | Upper Penninsula Power |
| 16 | Kansas City Power & Light |
| 17 | Public Service New Mexico |
| 18 | Carolina Power & Light |

TABLE J-2 Continued

| Company Number | Company Name |
|---|---|
| 19 | Duke Power |
| 20 | Cleveland Electric Illuminating |
| 21 | Columbus & Southern Ohio Electric |
| 22 | Ohio Edison |
| 23 | Duquesne Light |
| 24 | Pennsylvania Power |
| 25 | Pennsylvania Power & Light |
| 26 | West Penn Power |
| 27 | Blackstone Valley Electric |
| 28 | Black Hills Power |
| 29 | Central Power & Light |
| 30 | Texas Power & Light |
| 31 | West Texas Utilities |
| 32 | Utah Power & Light |
| 33 | Green Mountain Power |

Source: Federal Power Commission [222]

## TABLE J-3

## GEOGRAPHIC AREAS SERVED BY STRAIGHT ELECTRIC UTILITIES IN THE FINAL SAMPLE

| Company Number | Service Area |
|---|---|
| 1 | Serves 61 of Arkansas' 75 counties -- cities of Little Rock, Pine Bluff, Hot Springs, El Dorado. |
| 2 | Serves 3 million people in an area of Southern Florida north to St. Augustine on East coast and north to Sarasota on West coast -- cities of Miami, Miami Beach, Coral Gables, Hialeah, Hollywood, Ft. Lauderdale, Palm Beach, West Palm Beach, Daytona Beach, Ormond Beach, Melbourne, St. Augustine, Ft. Myers, Sarasota, Bradenton, Okeechobee. |
| 3 | Serves 2 million people in West Central and Northwest Florida -- cities of Apalachiocola, Brooksville, Clearwater, De Land, St. Petersburg. |
| 4 | Serves .5 million people in Northwest Florida -- cities of Panama City, Pensacola, Ft. Walton Beach. |
| 5 | Serves 700 thousand people in Hillsborough County, Florida -- cities of Tampa, Ruskin, Plant City, Dade City, Winter Haven. |
| 6 | Serves .5 million people in Southern Idaho, a portion of Eastern Oregon, and a small area of Northwest Nevada -- cities of Boise, Pocatello, and Caldwell in Idaho and Nysca and Vale in Oregon. |
| 7 | Serves 7.7 million people in Chicago metropolitan area. |
| 8 | Serves .4 million people in North and East Indiana and Southwest Michigan -- cities of Fort Wayne, South Bend, Muncie, Elkhart in Indiana and Benton Harbor in Michigan. |
| 9 | Operates in Southern two-thirds of Indiana (excluding Indianapolis) -- cities of Terre Haute, Kokomo, Lafayete, New Albany, Bloomington. |

TABLE J-3 Continued

| Company Number | Service Area |
|---|---|
| 10 | Serves .6 million people in Southeast Kansas -- cities of Wichita, Pittsburg, Arkansas City, Independence, Newton. |
| 11 | Serves 1 million people in an extensive area of North and East Louisiana -- cities of Bogalusa, Gretna, Kenner, Bastrop. |
| 12 | Serves .7 million people in central, Southern and Western Maine -- cities of Lewiston, Auburn, Augusta, Rumford. |
| 13 | Serves 1.5 million people in Boston metropolitan area. |
| 14 | Serves 5 million people in Detroit metropolitan area and Southeast Michigan. |
| 15 | Serves 166 thousand people on Michigan's upper peninsula -- cities of Calumet, Hancock, Houghton. |
| 16 | Serves .9 million people in Kansas City, Missouri metropolitan area. |
| 17 | Serves .4 million people in North central New Mexico -- 80 percent are in the Albuquerque metropolitan area. |
| 18 | Serves 2.5 million people in North and South Carolina -- cities of Ashville, Raleigh, Wilmington in South Carolina and Florence, Sumpter in North Carolina. |
| 19 | Serves 3 million people in central North Carolina and Western South Carolina -- cities of Salem and Durham in North Carolina and Greenville and Spartanburg in South Carolina. |
| 20 | Serves 2.1 million people in Cleveland metropolitan area. |
| 21 | Serves 1.3 million people in Columbus, Ohio metropolitan area. |
| 22 | Serves 2.0 million people in Northeast and North central Ohio -- cities of Akron, Youngstown, Springfield, Lorain, Warren. |

TABLE J-3 Continued

| Company Number | Service Area |
|---|---|
| 23 | Serves 1.6 million people in Pittsburgh metropolitan area. |
| 24 | Serves .3 million people in Western Pennsylvania -- cities of Newcastle and Sharon. |
| 25 | Serves 2.4 million people in Central and Eastern Pennsylvania -- cities of Allentown, Bethlehem, Harrisburg, Hazelton, Lancaster, Scranton, Wilkes-Barre. |
| 26 | Serves 1.2 million people in West and North central Pennsylvania -- Washington, Butler, Monessen, Uniontown are major cities served. |
| 27 | Serves 200 thousand people in Rhode Island -- cities of Pawtucket, Woonsacket, Central Falls. |
| 28 | Serves 145 thousand people in Western South Dakota, Southeastern Montana and Eastern Wyoming. |
| 29 | Serves 1 million people in South Texas -- cities of Corpus Christi, Laredo and surrounding rural areas. |
| 30 | Serves .5 million people in Northeast and North central Texas -- cities of Waco, Irving, Garland, Richardson. |
| 31 | Serves 400 thousand people in North central Texas -- cities of Abilene, Vernon, Childress, Cisco and surrounding areas. |
| 32 | Serves most of Utah, Southeast Idaho and Southwest Wyoming, 1.2 million People -- Salt Lake City metropolitan area. |
| 33 | Most of Vermont -- cities of Montpelier, Burlington, Barre, and surrounding rural areas. |

Source: Moody's [143]

## TABLE J-4

## COMBINATION UTILITIES IN ORIGINAL SAMPLE

| Company Number | Company Name |
|---|---|
| 34 | Arizona Public Service |
| 35 | Pacific Gas & Electric |
| 36 | Southern California Edison |
| 37 | Public Service Colorado |
| 38 | Connecticut Light & Power |
| 39 | Hartford Electric Light |
| 40 | Central Illinois Light |
| 41 | Interstate Power |
| 42 | Iowa-Illinois Gas & Electric |
| 43 | Iowa Southern Utilities |
| 44 | Louisville Gas & Electric |
| 45 | Gulf States Utilities |
| 46 | Baltimore Gas & Electric |
| 47 | Consumers Power |
| 48 | Northern States Power |
| 49 | Missouri Power & Light |
| 50 | Union Electric |
| 51 | Sierra-Pacific Power |

TABLE J-4 Continued

| Company Number | Company Name |
|---|---|
| 52 | Public Service Electric & Gas |
| 53 | New York State Electric & Gas |
| 54 | Niagara-Mohawk Power |
| 55 | Cincinnati Gas & Electric |
| 56 | Dayton Power & Light |
| 57 | California-Pacific Utilities |
| 58 | Pacific Power & Light |
| 59 | Philadelphia Electric |
| 60 | Virginia Electric & Power |
| 61 | Superior Water, Light and Power |

Source: Federal Power Commission [222]

## TABLE J-5

## GEOGRAPHIC AREAS SERVED BY COMBINATION UTILITIES IN THE FINAL SAMPLE

| Company Number | Service Area |
|---|---|
| 34 | Serves 11 of Arizona's 14 counties -- 687,000 people -- cities of Phoenix, Flagstaff, Holbrook, Ehrenberg. |
| 35 | Serves 47 counties of North and central California -- cities of San Francisco, Oakland, Sacramento, San Jose, Berkley, Fresno. |
| 36 | Serves 7.3 million people in Central and Southern California -- Los Angeles metropolitan area. |
| 37 | Serves 1.5 million people in a large section of Colorado -- cities of Denver, Boulder, Grand Junction. |
| 38 | Serves 1.5 million people in a large section of Connecticut -- cities of Waterbury, Williamantic, Bristol, New Britain, Danbury, Meriden, Greenwich. |
| 39 | Serves area in Connecticut with 800 thousand population -- cities of Hartford, Torrington, Darien, Stanford. |
| 40 | Serves 412 thousand people in Central Illinois -- cities of Peoria, Springfield, Pekin. |
| 41 | Serves 23 counties in North and Northeastern Iowa, 22 counties in Southern Minnesota, and 4 counties in Northwestern Illinois -- cities of Dubuque, Mason City, Clinton. |
| 42 | Serves cities of Davenport, Fort Dodge, Iowa City in Iowa and a small portion of Northeastern Illinois -- 500 thousand people live in the area. |
| 43 | Serves 238 thousand people in Southern and Southeastern Iowa -- cities of Burlington, Newton, Creston, Centerville, Grinnell. |

TABLE J-5 Continued

| Company Number | Service Area |
|---|---|
| 44 | Serves Louisville metropolitan area. |
| 45 | Serves 1.2 million people in Southeastern Texas and South Central Louisiana -- cities of Beaumont, Port Arthur, Baton Rouge. |
| 46 | Serves Baltimore metropolitan area. |
| 47 | Serves 4.5 million people on Michigan's Southern Peninsula, excluding Detroit area. |
| 48 | Serves 20 counties in West central Wisconsin with 381 thousand people -- cities of La Crosse, Eau Claire, Chippewa Falls, Menomonie, Sparta. |
| 49 | Serves most of Missouri North of the Missouri River, from La Grange on East to Plattsburg, on west -- 277 thousand people -- cities of Jefferson City, Moberly, Kirksville, Mexico, Boonville. |
| 50 | Serves 2.2 million people in East and Central Missouri -- St. Louis metropolitan area major city served -- also cities of St. Charles, Crystal City, De Soto. |
| 51 | Diagonal across state of Nevada from Southeast corner to Northeast corner -- 223 thousand people -- cities of Reno, Sparks, Carson City. |
| 52 | Serves 4 million people in Northeast and central New Jersey -- cities of Newark, Jersey City, Patterson, Trenton, Camden, Elizabeth, Bayonne, Hoboken, Passaic, Orange, Hackensack, Englewood, Union City, Perth, Amboy. |
| 53 | Serves 1.6 million people in South central, Eastern and Western New York -- cities of Binghamton, Elmira, Auburn, Ithaca, Corning, Geneva, Lockport. |
| 54 | Serves 4 million people throughout New York State -- cities of Buffalo, Syracuse, Albany, Utica, Schenectady, Troy. |
| 55 | Serves 1.5 million people in Cincinnati and the ten surrounding counties -- cities of Middletown, Norwood. |

TABLE J-5 Continued

| Company Number | Service Area |
|---|---|
| 56 | Serves 24 counties around Dayton, Ohio with 1.2 million population -- cities of Dayton, Kettering, Fairborn, Xenia. |
| 57 | Serves 1.5 million people in Northern California, Southern Oregon, and scattered places in Central and West Central Oregon -- cities of Portland, Springfield, Yakima, Corvallis in Oregon, Walla Walla in Washington, Casper in Wyoming. |
| 58 | Serves 4 million people in Philadelphia metropolitan area. |
| 59 | Serves 3.4 million people throughout the state of Virginia -- cities of Norfolk, Richmond, Virginia Beach, Newport News, Hampton, Alexandria. |
| 60 | Serves 228 thousand people in Madison, Wisconsin metropolitan area. |
| 61 | Serves 815 thousand people in Central and Southeastern Wisconsin -- cities of Sheboygan, Fond du Lac, Beloit, Janesville, Ripon, Beaver Dam, Monroe. |

Source: Moody's [143]

# APPENDIX K

## PROBLEMS ENCOUNTERED IN THE APPLICATION OF MULTIPLE REGRESSION TO CROSS-SECTIONAL DATA

Cross-sectional data consist of observations made simultaneously [160]. For example, sales on a particular day may be recorded for each city, county, or state in a particular geographic region. In the case of this research project it is a question of recording sales and other data for a sample of electric utility firms during a given period of time. Using cross-sectional data enables the researcher to avoid some of the problems associated with time-series data, but it creates other problems [160]. Two major problems encountered with cross-sectional data are heterogeneity between observational units and the difficulty of isolating observational units [235, p. 355].

### Heterogeneity

One big problem with cross-sectional data is the lack of homogeneity -- the heterogeneity -- between observational units [235, p. 353]. For instance, even if a set of retail stores of approximately the same size are used, each will have different characteristics -- different clienteles, different locations, and different marketing philosophies. These factors will influence the dependent variable by different amounts. If these different characteristics are not included explicitly in the model their effects will, nevertheless, be reflected in the variation of the dependent variable. The differences in the observational units will, therefore, be reflected in the residuals of the regression analysis where their effect will be inseperable from statistical error [235, p. 355].

The researcher can do several things to compensate for this problem in cross-sectional studies. First, the researcher should take care to see that the observational units are as similar as possible [160]. A second device involves adjusting the observations for differences in the units [235, p. 355]. A final safeguard entails seeing that all important factors which affect the dependent variable are explicitly included in the model [235, p. 355].

There is no question that the cross-sectional data employed in this study are subject to a significant heterogeneity problem. However, it would seem that this problem is largely compensated for by the inclusion of all the important determinants of residential electricity sales in the model. Certainly, not all the determinants of residential electricity sales are considered. For example, sizes and ages of homes in the various market areas are potentially significant electricity sales determinants that are not included in the model.

## Isolation

Isolating the observational units can be a difficult problem with cross-sectional data [235, p. 354]. It is possible that the value of the independent variable (or variables) in one observational unit may affect the value of the dependent variable in another observational unit. For example, a low price at one gas station may attract people that ordinarily shop at another station. Whether this outcome is undesirable or will distort the conclusions of the study depends on the purpose or nature of the study. If the study was being conducted for the purpose of determining what effect a general price reduction would have on the total demand for gasoline the above mentioned occurance would distort the study's conclusions.

Isolation is not a problem in the study of the determinants of the residential demand for electricity. Residential electricity buyers in one market cannot go to another market to buy their electricity. The price of electricity in one market is not likely to affect electricity prices or sales in another market. Income, weather conditions, appliance stocks, and advertising in one market are not likely to affect these factors or sales in other markets. In conclusion, it would appear that electricity markets are effectively isolated from each other so that values of the independent variables in one market are not likely to affect values of the dependent variable (sales) in other markets.

# APPENDIX L

## DESCRIPTION OF DATA SERIES EMPLOYED IN THE CROSS-SECTIONAL ANALYSIS

In Chapter III a number of factors were hypothesized to be important determinants of the residential demand for electricity. More specifically, per customer residential sales of electricity were hypothesized to be a function of the price of electricity, per customer advertising expenditures by electric utilities, per capita or per family income, weather conditions, and the per customer stock of electrical appliances or electricity consuming devices. It was suggested in Chapter III that per customer residential sales of electricity could be expected to increase as price decreases, or as advertising increases, or as the per capita or per family income increases, or as the per customer stock of residential appliances increases. The relationship between weather conditions and electricity sales was uncertain at that point. It was suggested in Chapter III that per customer consumption of electricity would tend to be higher in warmer areas of the country.

Sources of data, to represent the various factors discussed above, will be explored in this section. The collection of data for individual firms in the cross-sectional sample was considerably more tedious than was the collection of data for the industry in the time-series analysis. Data for the individual firms in the sample were collected for three different years -- 1965, 1967, 1969. The three years provide some basis for comparing the results obtained in individual years. If only one year had been used the researcher would not be sure whether the results obtained were an historical accident or not.

### Sales, Price and Advertising Data

Per customer kilowatt hour sales data were obtained from the Federal Power Commission's *Statistics of Privately Owned Electric Utilities* [222].

The price of 250 kilowatt hours was chosen as the relevant measure of price for the time-series analysis. This choice was based on the fact that the average residential customer used about 250 kilowatt hours of electricity per month in the middle years of the 1951-1970 period. The cross sectional analysis involves the years 1965, 1967 and 1969. During these years the average residential customer used about 500 kilowatt hours of electricity per month [222, p. XXXV]. The price of 500 kilowatt hours of electricity was, therefore, chosen as the relevant measure of electricity price for the cross-sectional analysis. These data were obtained for the utilities in the sample from the Federal Power Commission's *Typical Electric Bills* [223].

Per customer advertising expenditures for the utilities in the sample were computed on the basis of Federal Power Commission data [222]. Per customer advertising expenditures were calculated by dividing each utility's total advertising expenditures by the total number of residential customers it served.

### Income Data

Median family income was previously cited as the preferred measure of income for this study. This measure was preferred because the family is the basic consuming unit for electricity. It was impossible to obtain median family income data for the geographic areas served by firms in the cross-sectional sample. It was, however, possible to obtain per capita personal income data for the areas served by individual utilities.

The major obstacle to the assembly of income data for the market areas of the firms in the sample was that the areas served by these firms are in most cases different from the areas for which income statistics are reported. The utilities in the sample can be separated into four categories according to the geographic areas they serve.

1. First there are those firms that serve areas which are coincident or roughly coincident with Standard Metropolitan Statistical areas defined by the Bureau of the Census. Eighteen of the 61 utilities in the sample fall into this category. Dallas Power and Light and Indianapolis Power and Light are examples of firms that serve areas coincident with Standard Metropolitan Statistical Areas.
2. Second, there are those electric utilities which serve entire states or large sections of entire states. Six utilities in the sample, including Arkansas Power and Light and Idaho Power and Light, fall into this category.
3. Third, there are those electric utilities which serve largely rural sections of particular states. Sixteen of the companies in the sample, including Iowa Southern Utilities and Missouri Edison Company fit into this category.

4. Finally, there are those utilities which serve one or more Standard Metropolitan Statistical Areas and surrounding rural areas. Twenty-one utilities in the sample, including Florida Power and Light and Pacific Gas and Electric, fit into this category.

Obtaining per capita personal income data for those utilities serving one state or one Standard Metropolitan Statistical Area was not a problem. State per capita personal income was used for those utilities that serve entire states. These data were obtained from the Statistical Abstract of the United States [213]. Standard Metropolitan Statistical Area personal income data were used for those utilities that serve areas coincident with particular Standard Metropolitan Statistical Areas. These data were obtained from a special report entitled "Personal Income in Metropolitan and Nonmetropolitan Areas" which appeared in the April 1971 issue of the Survey of Current Business [215].

The assembly of personal income data for utilities that serve rural areas or several metropolitan areas and surrounding rural areas was considerably more difficult. Per capita personal income for rural areas was estimated by following a process which included several steps. First, an atlas was used to determine the specific counties served by each of the utilities which operate in rural areas. Next, the 1967 County and City Data Book was consulted to find the per capita personal income for each of the counties in a particular rural utility's service area [211]. Per capita personal income in the various counties in a particular rural utility's service area were weighted by county population and then averaged to obtain an estimate of per capita personal income for the rural region in question [210]. Finally, this figure was divided by the particular state's per capita personal income to obtain a ratio which could be applied to the state per capita personal income to obtain estimates of per capita personal income in the rural utility's service area in 1967 and 1969.[1] A similar procedure was followed to arrive at per capita personal income for the market areas of utilities which serve several Standard Metropolitan Statistical Areas and surrounding rural areas.

Weather Data

The cross-sectional sample includes invividual electric utility firms which operate in specific geographic regions. It was, therefore, possible to obtain several measures of weather and climate relevant to residential electric power consumption. These weather measures are discussed below. All of the weather data were obtained from the Environmental Service Administration's publication Climatological Data: National Summary [214].

Heating degree days -- This statistic is computed for days which have an average temperature of less than 65 degrees fahrenheit. The number of heating degree days for such a day would equal 65 minus the average temperature for that day [214, p. 79]. If the mean temperature for a particular day was 32 degrees the number of heating degree days for that day would be 33 [214, p. 62]. This data is reported for specific cities on an annual basis. The number of heating degree days experienced in a particular area during a particular year reflect the relative need for home heating in that area in that year.

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[1] The 1967 County and City Data Book contains income data for 1965 [211].

Cooling degree days -- This statistic is computed for days which have an average temperature greater than 65 degrees fahrenheit [214, p. 63]. The number of cooling degree days for such a day would equal the average temperature for that day minus 65 [214, p. 80]. If the average temperature for a particular day was 85 degrees, twenty cooling degree days would be accumulated for that day. The number of cooling degree days experienced in a particular area during a given year provide a relative measure of the need for home air conditioning in that area for that year.

Average relative humidity -- This variable was selected for possible inclusion in the model because high relative humidity tends to make people feel more uncomfortable at any given temperature than they would feel at that temperature with a lower relative humidity [214, p. 663]. For this reason it seems reasonable to suggest that relative humidity might have some effect on the demand for electricity for both home heating and home cooling.

Days over 90 degrees fahrenheit -- This information was collected as an alternative measure of the need for home cooling. These data show the number of days that the maximum temperature exceeded 90 degrees fahrenheit in a particular area during a given year [214, p. 663].

Number of days under 32 degrees -- This information was collected as an alternative measure of the need for home heating. These data show the number of days that the minimum temperature fell below 32 degrees fahrenheit in a particular area during a given year [214, p. 663].

Data collection problems -- The various types of weather data discussed in this section are all available for only a limited number of specific geographic points. Weather data are available from 281 weather stations in the United States [214, pp. 663-669]. The fact that weather data are available for only specific geographic points while utilities serve broad geographic regions presented a problem. In the case of those utilities which serve Standard Metropolitan Statistical areas the weather data reported by the most central weather station in that metropolitan area was assumed to apply to the entire metropolitan area. In the case of those utilities which serve entire states, weighted (by population) weather data were computed using weather data from the state's major cities. A similar procedure was followed to derive weather data for the market areas of utilities which serve several metropolitan areas and surrounding rural areas.

## Residential Appliance and Electrical Device Stocks

Ownership data for the seven highest electricity consuming appliances was collected for the market areas of all the utility firms in the sample. This data was obtained from the Annual Statistical and Marketing Reports of Merchandising Week [189]. The seven appliances employed in this study and their annual average kilowatt hour consumption rates are shown in Table L-1.

In addition to appliances there are other electricity consuming devices whose stock should have a significant impact on the residential demand for electricity [72,224,240]. Central electric air conditioning and central electric heating systems, for example, should have a significant impact on the residential demand for electricity [224, I-3-8].

## TABLE L-1

## THE SEVEN HIGHEST ELECTRICITY CONSUMING APPLIANCES (1969)

| Appliance | Average Annual KWH Consumption |
|---|---|
| Water Heaters | 4219 |
| Air Conditioners (Room) | 1389 |
| Home Freezers | 1195 |
| Electric Ranges | 1175 |
| Clothes Dryers | 993 |
| Dishwashers | 363 |
| Washers (Automatic) | 103 |

Source: Federal Power Commission [222, I-3-9]

There are no data available that would permit the computation of the number of homes in a particular utility's service area which have central air conditioning or central electric heat. There are data available on the number of all-electric homes in the service areas of the various utilities in the sample [219]. A home must have electric heat and air conditioning and use electricity as the sole energy source to be classified as all-electric. Data on the number of all-electric homes in the market areas of the various utilities in the sample were obtained from the Federal Power Commission publication All Electric Homes in the United States [219]. These data provide a rough estimate of the number of residential electric central heating and air conditioning in operation in a particular utility's marketing area. The total number of all-electric homes in a particular utility's service area was divided by the total number of homes served by that firm to arrive at all-electric homes per residential customer.

## Appliance Stock Index

An index was developed to represent the per customer stock of electrical appliances. This index was developed along the same lines as the appliance stock index discussed in Chaper IV. The necessity of developing an index to summarize the information contained in the seven appliance series was prompted by two considerations. First, the law of parsimony of variables dictates that the researcher adopt the simplest model that will adequately describe the phenomenon he is studying [73, p. 58]. Second, preliminary regressions indicated the existence of considerable collinearity between the various appliance series. One way to deal with the collinearity problem is to reduce the number of variables in the model [102, pp. 159-168].

The per customer ownership figures for the sevel appliances, shown in Table L-1, were weighted by the relative power usage rates of each appliance. The weighted per customer ownership data for the seven appliances were then summed to provide an appliance stock index. This index has a lower limit of zero (if per customer ownership of each of the seven appliances equals zero) and an upper limit of unity (if per customer ownership of each of the seven appliances is equal to one). An example, showing computation of the appliance stock index for the Arizona Public Service Company, is given in Table L-2.

## TABLE L-2

## COMPUTATION OF THE PER CUSTOMER APPLIANCE STOCK INDEX FOR THE ARIZONA PUBLIC SERVICE COMPANY (1969)

| Appliance | Per Customer Ownership | Usage Weighting Factor | Weighted Score |
|---|---|---|---|
| Water Heaters | .08 | .447 | .036 |
| Room Air Conditioners | .12 | .147 | .018 |
| Home Freezers | .20 | .127 | .025 |
| Electric Ranges | .35 | .124 | .043 |
| Clothes Dryers | .15 | .105 | .016 |
| Dishwashers | .20 | .038 | .008 |
| Washers (Automatic) | .65 | .010 | .007 |
| Appliance Stock Index | | | .153 |

Source: Merchandising Week [189]

# APPENDIX M

## CROSS-SECTIONAL DATA

This appendix contains all the data employed or considered in the analysis presented in Chapter IV. All the symbols employed in this appendix are defined in Table M-1. The firms selected as part of the straight electric utility sample are listed in Table M-2 along with numbers used to identify them in subsequent tables. The same information is presented for the combination utility sample in Table M-3. Tables M-4 through M-9 show the per customer ownership of seven major appliances in the service areas of each utility, in both the combination and straight electric utility samples, for the years 1965, 1967, and 1969. These data were obtained from Billboard Publications Statistical and Marketing Report [189]. Price, income, appliance stock index, all-electric home, and advertising expenditure data for the firms are presented in Tables M-10 through M-15. Prices charged by the firms for various quantities of electricity were obtained from Typical Electric Bills, a Federal Power Commission publication [223]. Per capita personal income estimates were derived from Office of Business Economics statistics presented in the Survey of Current Business [215]. All-electric home data were obtained from All-Electric Homes in the United States, a Federal Power Commission publication [219]. Advertising expenditure data for the firms sampled were also obtained from a Federal Power Commission publication, Statistics of Privately Owned Electric Utilities in the United States [222].

Finally, weather data for the service areas of the various firms are presented in Tables M-16 through M-21. These data were obtained from the Environmental Data Service's _Climatological Data_: _National Summary_ [214].

## TABLE M-1

## DEFINITIONS OF SYMBOLS USED IN APPENDIX M

| Symbol | Definition |
|---|---|
| $A_1$ | Per customer ownership of electric water heaters |
| $A_2$ | Per customer ownership of electric room air conditioners |
| $A_3$ | Per customer ownership of electric home freezers |
| $A_4$ | Per customer ownership of electric ranges |
| $A_5$ | Per customer ownership of electric dryers |
| $A_6$ | Per customer ownership of electric dishwashers |
| $A_7$ | Per customer ownership of electric clothes washers |
| $A_x$ | Per customer appliance stock index |
| E | All-electric homes per customer |
| $P_2$ | Price of 250 kilowatt hours of electricity |
| $P_4$ | Advertising expenditures per customer |
| $P_5$ | Price of 500 kilowatt hours of electricity |
| S/C | Per customer kilowatt hour sales |
| $W_1$ | Number of heating degree days |
| $W_2$ | Number of cooling degree days |
| $W_3$ | Average relative humidity |
| $W_4$ | Number of days with a maximum temperature of more than 90 degrees Fahrenheit |
| $W_5$ | Number of days with a minimum temperature of less than 32 degrees Fahrenheit |
| Y | Per capita personal income |

## TABLE M-2

## STRAIGHT ELECTRIC UTILITY FIRMS FOR WHICH DATA WERE COLLECTED WITH NUMBERS USED TO IDENTIFY THEM IN APPENDIX M

| Company Number | Company Name |
|---|---|
| 1 | Arkansas Power and Light |
| 2 | Florida Power and Light |
| 3 | Florida Power |
| 4 | Gulf Power |
| 5 | Tampa Electric |
| 6 | Idaho Power |
| 7 | Commonwealth Edison |
| 8 | Indiana & Michigan Power |
| 9 | Public Service Indiana |
| 10 | Kansas Gas and Electric |
| 11 | Louisiana Power and Light |
| 12 | Central Maine Power |
| 13 | Boston Edison |
| 14 | Detroit Edison |
| 15 | Upper Penninsula Power |
| 16 | Kansas City Power and Light |
| 17 | Public Service New Mexico |
| 18 | Carolina Power and Light |
| 19 | Duke Power |
| 20 | Cleveland Electric Illuminating |
| 21 | Columbus & Southern Ohio Electric |
| 22 | Ohio Edison |
| 23 | Duquesne Light |
| 24 | Pennsylvania Power |
| 25 | Pennsylvania Power and Light |
| 26 | West Penn Power |
| 27 | Blackstone Valley Electric |
| 28 | Black Hills Power |
| 29 | Central Power and Light |
| 30 | Texas Power and Light |
| 31 | West Texas Utilities |
| 32 | Utah Power and Light |
| 33 | Green Mountain Power |

Source: Federal Power Commission [222]

## TABLE M-3

## COMBINATION UTILITY FIRMS FOR WHICH DATA WERE COLLECTED WITH NUMBERS USED TO IDENTIFY THEM IN APPENDIX M

| Company Number | Company Name |
|---|---|
| 34 | Arizona Public Service |
| 35 | Pacific Gas and Electric |
| 36 | Southern California Edison |
| 37 | Public Service Colorado |
| 38 | Connecticut Light and Power |
| 39 | Hartford Electric Light |
| 40 | Central Illinois Power |
| 41 | Interstate Power |
| 42 | Iowa-Illinois Gas and Electric |
| 43 | Iowa Southern Utilities |
| 44 | Louisville Gas and Electric |
| 45 | Gulf States Utilities |
| 46 | Baltimore Gas and Electric |
| 47 | Consumers Power |
| 48 | Northern States Power |
| 49 | Missouri Power and Light |
| 50 | Union Electric |
| 51 | Sierra-Pacific Power |
| 52 | Public Service Electric and Gas |
| 53 | New York State Electric and Gas |
| 54 | Niagara-Mohawk Power |
| 55 | Cincinnati Gas and Electric |
| 56 | Dayton Power and Light |
| 57 | California-Pacific Utilities |
| 58 | Pacific Power and Light |
| 59 | Philadelphia Electric |
| 60 | Virginia Electric and Power |
| 61 | Superior Water, Light and Power |

Source: Federal Power Commission [222]

## TABLE M-4

## PER CUSTOMER OWNERSHIP OF SEVEN MAJOR ELECTRICAL APPLIANCES IN THE SERVICE AREAS OF FIRMS IN THE STRAIGHT ELECTRIC UTILITY SAMPLE (1965)

| Company Number | S/C | $A_1$ | $A_2$ | $A_3$ | $A_4$ | $A_5$ | $A_6$ | $A_7$ |
|---|---|---|---|---|---|---|---|---|
| 1 | 4140 | .42 | .48 | .30 | .06 | .51 | .19 | .12 |
| 2 | 6580 | .08 | .32 | .61 | .62 | .61 | .14 | .07 |
| 3 | 6010 | .12 | .37 | .75 | .77 | .53 | .11 | .09 |
| 4 | 6640 | .37 | .35 | .58 | .40 | .73 | .16 | .10 |
| 5 | 6920 | .25 | .49 | .75 | .79 | .85 | .13 | .30 |
| 6 | 8280 | .55 | .23 | .92 | .86 | .81 | .62 | .16 |
| 7 | 3870 | .10 | .24 | .18 | .06 | .70 | .12 | .07 |
| 8 | 6680 | .23 | .16 | .66 | .44 | .56 | .48 | .09 |
| 9 | 5070 | .25 | .15 | .56 | .35 | .55 | .25 | .10 |
| 10 | 4790 | .25 | .48 | .42 | .05 | .65 | .40 | .12 |
| 11 | 5620 | .52 | .51 | .32 | .04 | .68 | .25 | .22 |
| 12 | 3580 | .23 | .03 | .45 | .30 | .35 | .14 | .08 |
| 13 | 3090 | .10 | .08 | .35 | .07 | .75 | .20 | .10 |
| 14 | 4260 | .18 | .09 | .44 | .14 | .61 | .20 | .09 |
| 15 | 3100 | .06 | .03 | .65 | .15 | .42 | .20 | .02 |
| 16 | 4400 | .00 | .59 | .44 | .09 | .77 | .28 | .00 |
| 17 | 3700 | .29 | .00 | .56 | .04 | .70 | .25 | .18 |
| 18 | 6620 | .27 | .36 | .56 | .45 | .46 | .08 | .12 |
| 19 | 6120 | .25 | .30 | .60 | .70 | .65 | .12 | .05 |
| 20 | 4200 | .22 | .12 | .32 | .08 | .57 | .31 | .16 |
| 21 | 4240 | .20 | .18 | .39 | .12 | .57 | .38 | .14 |
| 22 | 4510 | .21 | .10 | .22 | .14 | .47 | .32 | .08 |
| 23 | 3650 | .19 | .11 | .27 | .03 | .53 | .25 | .09 |
| 24 | 4800 | .25 | .08 | .51 | .21 | .49 | .41 | .08 |
| 25 | 4390 | .21 | .09 | .48 | .22 | .54 | .24 | .05 |
| 26 | 4850 | .26 | .07 | .48 | .26 | .53 | .42 | .08 |
| 27 | 2550 | .02 | .10 | .26 | .04 | .55 | .08 | .02 |
| 28 | 4460 | .20 | .15 | .65 | .25 | .75 | .30 | .08 |
| 29 | 4730 | .24 | .28 | .23 | .06 | .49 | .11 | .05 |
| 30 | 5160 | .22 | .43 | .27 | .03 | .57 | .11 | .10 |
| 31 | 4110 | .33 | .14 | .37 | .10 | .72 | .16 | .14 |
| 32 | 5070 | .31 | .05 | .68 | .26 | .65 | .38 | .16 |
| 33 | 5220 | .03 | .01 | .50 | .25 | .50 | .30 | .05 |

Source: Billboard Publications, _Statistical and Marketing Report_ [189]

## TABLE M-5

## PER CUSTOMER OWNERSHIP OF SEVEN MAJOR ELECTRICAL APPLIANCES IN THE SERVICE AREAS OF FIRMS IN THE STRAIGHT ELECTRIC UTILITY SAMPLE (1967)

| Company Number | S/C | $A_1$ | $A_2$ | $A_3$ | $A_4$ | $A_5$ | $A_6$ | $A_7$ |
|---|---|---|---|---|---|---|---|---|
| 1 | 4686 | .33 | .28 | .30 | .06 | .40 | .14 | .10 |
| 2 | 7712 | .09 | .36 | .65 | .65 | .58 | .15 | .09 |
| 3 | 6747 | .13 | .43 | .76 | .79 | .59 | .13 | .10 |
| 4 | 7651 | .36 | .39 | .60 | .42 | .80 | .25 | .28 |
| 5 | 7843 | .25 | .43 | .76 | .80 | .71 | .15 | .25 |
| 6 | 8780 | .51 | .09 | .96 | .85 | .81 | .67 | .04 |
| 7 | 4391 | .20 | .30 | .19 | .07 | .77 | .14 | .10 |
| 8 | 7517 | .26 | .20 | .67 | .44 | .61 | .56 | .13 |
| 9 | 5886 | .32 | .17 | .46 | .41 | .49 | .34 | .08 |
| 10 | 5175 | .29 | .55 | .45 | .07 | .73 | .47 | .15 |
| 11 | 6700 | .51 | .49 | .29 | .09 | .80 | .25 | .25 |
| 12 | 3976 | .28 | .04 | .64 | .44 | .82 | .27 | .11 |
| 13 | 3588 | .11 | .08 | .40 | .07 | .80 | .25 | .15 |
| 14 | 4794 | .21 | .15 | .47 | .14 | .70 | .26 | .14 |
| 15 | 3349 | .20 | .05 | .65 | .50 | .55 | .30 | .10 |
| 16 | 4848 | .22 | .42 | .34 | .06 | .45 | .20 | .15 |
| 17 | 4073 | .31 | .00 | .57 | .05 | .65 | .28 | .16 |
| 18 | 7455 | .46 | .25 | .82 | .70 | .63 | .14 | .10 |
| 19 | 7258 | .31 | .17 | .82 | .74 | .56 | .14 | .09 |
| 20 | 4661 | .25 | .15 | .30 | .08 | .65 | .32 | .15 |
| 21 | 4732 | .21 | .21 | .41 | .13 | .65 | .45 | .15 |
| 22 | 4978 | .23 | .13 | .53 | .13 | .48 | .35 | .10 |
| 23 | 4066 | .15 | .14 | .24 | .03 | .58 | .21 | .11 |
| 24 | 5295 | .28 | .11 | .54 | .21 | .53 | .47 | .10 |
| 25 | 5324 | .22 | .09 | .52 | .25 | .53 | .25 | .08 |
| 26 | 5452 | .28 | .10 | .50 | .26 | .61 | .44 | .14 |
| 27 | 2984 | .02 | .13 | .29 | .07 | .70 | .12 | .05 |
| 28 | 4714 | .29 | .26 | .68 | .26 | .75 | .38 | .13 |
| 29 | 5630 | .24 | .31 | .24 | .08 | .48 | .13 | .09 |
| 30 | 6060 | .32 | .36 | .31 | .03 | .58 | .16 | .15 |
| 31 | 4583 | .35 | .18 | .39 | .12 | .74 | .20 | .17 |
| 32 | 5374 | .35 | .00 | .71 | .24 | .70 | .43 | .20 |
| 33 | 6371 | .05 | .01 | .60 | .33 | .60 | .30 | .08 |

Source: Billboard Publications, Statistical and Marketing Report [189]

## TABLE M-6

## PER CUSTOMER OWNERSHIP OF SEVEN MAJOR ELECTRICAL APPLIANCES IN THE SERVICE AREAS OF FIRMS IN THE STRAIGHT ELECTRIC UTILITY SAMPLE
## (1969)

| Company Number | S/C | $A_1$ | $A_2$ | $A_3$ | $A_4$ | $A_5$ | $A_6$ | $A_7$ |
|---|---|---|---|---|---|---|---|---|
| 1 | 6204 | .38 | .37 | .23 | .06 | .54 | .20 | .10 |
| 2 | 9826 | .08 | .37 | .65 | .65 | .59 | .17 | .10 |
| 3 | 8666 | .18 | .43 | .75 | .73 | .63 | .24 | .14 |
| 4 | 9726 | .41 | .60 | .63 | .44 | .77 | .22 | .12 |
| 5 | 10023 | .23 | .38 | .80 | .87 | .68 | .22 | .12 |
| 6 | 9500 | .55 | .11 | .96 | .85 | .83 | .70 | .07 |
| 7 | 5173 | .21 | .35 | .20 | .07 | .79 | .15 | .13 |
| 8 | 8713 | .30 | .24 | .70 | .44 | .75 | .60 | .00 |
| 9 | 6914 | .15 | .33 | .47 | .43 | .54 | .40 | .11 |
| 10 | 6549 | .35 | .65 | .45 | .07 | .78 | .51 | .20 |
| 11 | 8564 | .51 | .47 | .29 | .10 | .80 | .30 | .28 |
| 12 | 4473 | .29 | .04 | .65 | .46 | .83 | .35 | .13 |
| 13 | 4082 | .11 | .16 | .30 | .11 | .66 | .17 | .15 |
| 14 | 5563 | .20 | .20 | .50 | .15 | .75 | .29 | .16 |
| 15 | 3568 | .20 | .05 | .68 | .53 | .55 | .35 | .11 |
| 16 | 6127 | .31 | .52 | .49 | .07 | .62 | .27 | .20 |
| 17 | 4668 | .40 | .05 | .61 | .11 | .72 | .38 | .33 |
| 18 | 9020 | .45 | .30 | .78 | .75 | .58 | .16 | .10 |
| 19 | 8928 | .39 | .20 | .85 | .76 | .64 | .19 | .12 |
| 20 | 5334 | .24 | .16 | .33 | .08 | .00 | .34 | .18 |
| 21 | 5682 | .36 | .22 | .53 | .17 | .85 | .51 | .26 |
| 22 | 5750 | .27 | .17 | .54 | .13 | .54 | .40 | .13 |
| 23 | 4677 | .20 | .20 | .25 | .03 | .58 | .23 | .16 |
| 24 | 5789 | .30 | .20 | .56 | .22 | .98 | .50 | .12 |
| 25 | 6459 | .26 | .19 | .56 | .28 | .60 | .35 | .11 |
| 26 | 6218 | .30 | .15 | .52 | .28 | .70 | .48 | .20 |
| 27 | 3558 | .05 | .15 | .30 | .12 | .80 | .20 | .07 |
| 28 | 5207 | .32 | .28 | .67 | .26 | .75 | .39 | .19 |
| 29 | 6964 | .24 | .31 | .26 | .09 | .50 | .17 | .10 |
| 30 | 8332 | .37 | .35 | .35 | .07 | .67 | .24 | .22 |
| 31 | 5551 | .37 | .22 | .42 | .14 | .78 | .24 | .19 |
| 32 | 5904 | .40 | .10 | .75 | .23 | .75 | .50 | .24 |
| 33 | 7868 | .12 | .04 | .66 | .70 | .39 | .38 | .13 |

Source: Billboard Publications, *Statistical and Marketing Report* [189]

## TABLE M-7

## PER CUSTOMER OWNERSHIP OF SEVEN MAJOR ELECTRICAL APPLIANCES IN THE SERVICE AREAS OF FIRMS IN THE COMBINATION UTILITY SAMPLE (1965)

| Company Number | S/C | $A_1$ | $A_2$ | $A_3$ | $A_4$ | $A_5$ | $A_6$ | $A_7$ |
|---|---|---|---|---|---|---|---|---|
| 34 | 4870 | .25 | .13 | .35 | .04 | .60 | .10 | .11 |
| 35 | 4450 | .23 | .08 | .37 | .10 | .71 | .24 | .19 |
| 36 | 3800 | .20 | .13 | .21 | .08 | .67 | .13 | .17 |
| 37 | 3560 | .32 | .12 | .45 | .07 | .69 | .25 | .20 |
| 38 | 4550 | .23 | .15 | .57 | .22 | .72 | .25 | .13 |
| 39 | 4420 | .15 | .10 | .47 | .15 | .65 | .21 | .15 |
| 40 | 4650 | .30 | .12 | .30 | .30 | .20 | .20 | .08 |
| 41 | 4240 | .34 | .15 | .34 | .37 | .37 | .26 | .05 |
| 42 | 3840 | .33 | .25 | .28 | .04 | .62 | .22 | .10 |
| 43 | 4030 | .40 | .35 | .40 | .38 | .38 | .25 | .11 |
| 44 | 4170 | .10 | .27 | .10 | .01 | .40 | .15 | .05 |
| 45 | 5950 | .36 | .40 | .40 | .08 | .46 | .21 | .00 |
| 46 | 3790 | .22 | .20 | .23 | .10 | .63 | .15 | .10 |
| 47 | 4820 | .26 | .04 | .51 | .35 | .46 | .26 | .06 |
| 48 | 4450 | .00 | .08 | .46 | .32 | .00 | .25 | .00 |
| 49 | 3600 | .28 | .26 | .36 | .21 | .40 | .16 | .01 |
| 50 | 4800 | .24 | .27 | .39 | .15 | .50 | .17 | .10 |
| 51 | 6290 | .25 | .05 | .85 | .75 | .90 | .35 | .55 |
| 52 | 3210 | .13 | .45 | .11 | .02 | .60 | .10 | .13 |
| 53 | 4330 | .23 | .05 | .38 | .18 | .48 | .25 | .08 |
| 54 | 4340 | .66 | .12 | .44 | .22 | .87 | .30 | .13 |
| 55 | 4560 | .24 | .21 | .25 | .16 | .45 | .21 | .14 |
| 56 | 4810 | .33 | .13 | .48 | .22 | .65 | .42 | .12 |
| 57 | 9860 | .52 | .13 | .90 | .80 | .70 | .53 | .18 |
| 58 | 4250 | .15 | .35 | .28 | .12 | .75 | .17 | .14 |
| 59 | 5480 | .24 | .16 | .49 | .28 | .55 | .13 | .08 |
| 60 | 5570 | .23 | .15 | .37 | .09 | .50 | .26 | .10 |
| 61 | 5250 | .46 | .05 | .46 | .43 | .47 | .33 | .05 |

Source: Billboard Publications, Statistical and Marketing Report [189]

## TABLE M-8

### PER CUSTOMER OWNERSHIP OF SEVEN MAJOR ELECTRICAL APPLIANCES IN THE SERVICE AREAS OF FIRMS IN THE COMBINATION UTILITY SAMPLE (1967)

| Company Number | S/C | $A_1$ | $A_2$ | $A_3$ | $A_4$ | $A_5$ | $A_6$ | $A_7$ |
|---|---|---|---|---|---|---|---|---|
| 34 | 5604 | .26 | .12 | .35 | .05 | .60 | .12 | .16 |
| 35 | 5000 | .23 | .08 | .37 | .10 | .71 | .24 | .19 |
| 36 | 4418 | .20 | .25 | .25 | .08 | .71 | .18 | .25 |
| 37 | 3903 | .30 | .09 | .51 | .04 | .72 | .27 | .25 |
| 38 | 5433 | .26 | .20 | .62 | .23 | .79 | .30 | .15 |
| 39 | 5035 | .15 | .14 | .48 | .15 | .71 | .26 | .19 |
| 40 | 5161 | .33 | .16 | .30 | .30 | .35 | .15 | .06 |
| 41 | 4582 | .36 | .29 | .36 | .35 | .46 | .33 | .08 |
| 42 | 4319 | .38 | .31 | .33 | .05 | .69 | .25 | .13 |
| 43 | 4580 | .35 | .19 | .32 | .21 | .41 | .18 | .07 |
| 44 | 4701 | .16 | .30 | .12 | .02 | .50 | .20 | .16 |
| 45 | 6810 | .40 | .41 | .41 | .09 | .69 | .22 | .12 |
| 46 | 4439 | .25 | .23 | .26 | .09 | .68 | .20 | .17 |
| 47 | 5298 | .33 | .06 | .57 | .37 | .47 | .29 | .08 |
| 48 | 4957 | .40 | .22 | .50 | .23 | .52 | .26 | .08 |
| 49 | 4113 | .32 | .30 | .40 | .21 | .45 | .17 | .02 |
| 50 | 5351 | .24 | .27 | .29 | .15 | .50 | .17 | .10 |
| 51 | 6695 | .28 | .07 | .92 | .70 | .91 | .55 | .21 |
| 52 | 3720 | .13 | .58 | .13 | .03 | .62 | .12 | .13 |
| 53 | 4782 | .25 | .07 | .41 | .18 | .55 | .29 | .10 |
| 54 | 4796 | .33 | .10 | .45 | .23 | .65 | .34 | .16 |
| 55 | 5088 | .24 | .26 | .40 | .25 | .65 | .32 | .19 |
| 56 | 5604 | .34 | .17 | .49 | .23 | .66 | .44 | .13 |
| 57 | 10382 | .53 | .16 | .92 | .80 | .72 | .58 | .20 |
| 58 | 4686 | .21 | .42 | .32 | .11 | .70 | .25 | .18 |
| 59 | 6301 | .25 | .16 | .52 | .32 | .60 | .19 | .11 |
| 60 | 5862 | .25 | .20 | .40 | .09 | .50 | .30 | .13 |
| 61 | 5686 | .32 | .14 | .52 | .45 | .35 | .28 | .12 |

Source: Billboard Publications, _Statistical_ _and_ _Marketing_ _Report_ [189]

## TABLE M-9

## PER CUSTOMER OWNERSHIP OF SEVEN MAJOR ELECTRICAL APPLIANCES IN THE SERVICE AREAS OF FIRMS IN THE COMBINATION UTILITY SAMPLE (1969)

| Company Number | S/C | $A_1$ | $A_2$ | $A_3$ | $A_4$ | $A_5$ | $A_6$ | $A_7$ |
|---|---|---|---|---|---|---|---|---|
| 34 | 6870 | .20 | .12 | .35 | .08 | .65 | .15 | .20 |
| 35 | 5550 | .25 | .08 | .40 | .07 | .70 | .28 | .24 |
| 36 | 5030 | .21 | .29 | .26 | .09 | .71 | .19 | .27 |
| 37 | 4480 | .34 | .10 | .53 | .05 | .74 | .30 | .31 |
| 38 | 6430 | .20 | .14 | .62 | .22 | .74 | .32 | .20 |
| 39 | 5800 | .16 | .24 | .52 | .17 | .73 | .34 | .20 |
| 40 | 6090 | .34 | .20 | .30 | .28 | .40 | .15 | .10 |
| 41 | 5280 | .37 | .35 | .39 | .32 | .59 | .40 | .14 |
| 42 | 5080 | .30 | .34 | .31 | .40 | .65 | .20 | .17 |
| 43 | 5510 | .42 | .25 | .38 | .26 | .55 | .35 | .10 |
| 44 | 5950 | .17 | .19 | .34 | .17 | .03 | .54 | .24 |
| 45 | 8600 | .44 | .45 | .44 | .11 | .73 | .29 | .28 |
| 46 | 5480 | .26 | .42 | .23 | .10 | .63 | .18 | .19 |
| 47 | 5950 | .33 | .10 | .58 | .35 | .51 | .31 | .11 |
| 48 | 5750 | .45 | .33 | .50 | .24 | .53 | .38 | .19 |
| 49 | 5030 | .33 | .30 | .40 | .20 | .45 | .18 | .03 |
| 50 | 6740 | .25 | .33 | .29 | .15 | .52 | .19 | .11 |
| 51 | 7420 | .30 | .08 | .93 | .70 | .93 | .60 | .25 |
| 52 | 4430 | .15 | .67 | .14 | .02 | .65 | .14 | .16 |
| 53 | 5430 | .27 | .09 | .42 | .18 | .59 | .33 | .12 |
| 54 | 5380 | .33 | .10 | .46 | .22 | .67 | .69 | .16 |
| 55 | 6130 | .27 | .33 | .46 | .21 | .68 | .37 | .24 |
| 56 | 6690 | .35 | .19 | .50 | .22 | .67 | .44 | .14 |
| 57 | 11450 | .23 | .09 | .94 | .74 | .78 | .58 | .22 |
| 58 | 5540 | .22 | .55 | .33 | .11 | .86 | .23 | .22 |
| 59 | 7930 | .28 | .23 | .55 | .35 | .59 | .20 | .11 |
| 60 | 6350 | .30 | .22 | .42 | .09 | .55 | .32 | .15 |
| 61 | 6380 | .49 | .20 | .52 | .41 | .51 | .40 | .13 |

Source: Billboard Publications, Statistical and Marketing Report [189]

## TABLE M-10

## WEATHER DATA FOR THE SERVICE AREAS OF FIRMS IN THE STRAIGHT ELECTRIC UTILITY SAMPLE (1965)

| Company Number | S/C | $W_1$ | $W_3$ | $W_4$ | $W_5$ |
|---|---|---|---|---|---|
| 1 | 4140 | 2916 | 58 | 81 | 60 |
| 2 | 6580 | 122 | 60 | 20 | 0 |
| 3 | 6010 | 588 | 57 | 69 | 3 |
| 4 | 6640 | 1486 | 63 | 24 | 14 |
| 5 | 6920 | 588 | 57 | 69 | 3 |
| 6 | 8280 | 5584 | 43 | 29 | 128 |
| 7 | 3870 | 6056 | 61 | 10 | 114 |
| 8 | 6680 | 6289 | 63 | 10 | 127 |
| 9 | 5070 | 5323 | 62 | 11 | 117 |
| 10 | 4790 | 4250 | 59 | 52 | 102 |
| 11 | 5620 | 1509 | 60 | 74 | 25 |
| 12 | 3580 | 7644 | 54 | 3 | 165 |
| 13 | 3090 | 6158 | 59 | 9 | 109 |
| 14 | 4260 | 6220 | 60 | 7 | 118 |
| 15 | 3100 | 8683 | 66 | 5 | 167 |
| 16 | 4400 | 4513 | 56 | 31 | 104 |
| 17 | 3700 | 4250 | 31 | 48 | 104 |
| 18 | 6620 | 3531 | 52 | 26 | 84 |
| 19 | 6120 | 3115 | 53 | 24 | 66 |
| 20 | 4200 | 6073 | 65 | 6 | 126 |
| 21 | 4240 | 5464 | 59 | 15 | 119 |
| 22 | 4510 | 6297 | 62 | 6 | 138 |
| 23 | 3650 | 5239 | 57 | 7 | 100 |
| 24 | 4800 | 6482 | 62 | 4 | 138 |
| 25 | 4390 | 5974 | 54 | 20 | 132 |
| 26 | 4850 | 5239 | 57 | 7 | 100 |
| 27 | 2550 | 6114 | 50 | 9 | 132 |
| 28 | 4460 | 7161 | 53 | 18 | 162 |
| 29 | 4730 | 854 | 64 | 107 | 6 |
| 30 | 5160 | 2202 | 60 | 99 | 37 |
| 31 | 4110 | 2250 | 50 | 105 | 44 |
| 32 | 5070 | 5804 | 43 | 31 | 133 |
| 33 | 5220 | 8157 | 57 | 5 | 172 |

Source: Environmental Data Service [214]

## TABLE M-11

## WEATHER DATA FOR THE SERVICE AREAS OF FIRMS IN THE STRAIGHT ELECTRIC UTILITY SAMPLE (1967)

| Company Number | S/C | $W_1$ | $W_3$ | $W_4$ | $W_5$ |
|---|---|---|---|---|---|
| 1 | 4686 | 3082 | 58 | 44 | 73 |
| 2 | 7712 | 94 | 61 | 33 | 0 |
| 3 | 6747 | 491 | 58 | 66 | 3 |
| 4 | 7651 | 1448 | 62 | 29 | 8 |
| 5 | 7843 | 491 | 58 | 66 | 3 |
| 6 | 8780 | 5671 | 53 | 69 | 135 |
| 7 | 4391 | 6259 | 60 | 4 | 108 |
| 8 | 7517 | 6580 | 64 | 1 | 125 |
| 9 | 5886 | 5410 | 60 | 9 | 109 |
| 10 | 5175 | 4441 | 51 | 42 | 104 |
| 11 | 6700 | 1576 | 59 | 64 | 24 |
| 12 | 3976 | 7817 | 61 | 2 | 170 |
| 13 | 3588 | 6153 | 60 | 3 | 103 |
| 14 | 4794 | 6306 | 59 | 5 | 119 |
| 15 | 3349 | 8737 | 72 | 1 | 173 |
| 16 | 4848 | 4619 | 58 | 28 | 95 |
| 17 | 4073 | 4171 | 32 | 46 | 115 |
| 18 | 7455 | 3323 | 53 | 17 | 73 |
| 19 | 7258 | 3036 | 53 | 14 | 56 |
| 20 | 4661 | 6062 | 60 | 8 | 115 |
| 21 | 4732 | 5846 | 62 | 5 | 114 |
| 22 | 4978 | 6500 | 62 | 5 | 130 |
| 23 | 4066 | 5421 | 58 | 5 | 104 |
| 24 | 5295 | 6863 | 64 | 4 | 137 |
| 25 | 5324 | 6386 | 55 | 5 | 140 |
| 26 | 5452 | 5421 | 58 | 5 | 104 |
| 27 | 2984 | 6266 | 57 | 1 | 128 |
| 28 | 4714 | 7215 | 50 | 24 | 177 |
| 29 | 5630 | 947 | 63 | 80 | 6 |
| 30 | 6060 | 2010 | 52 | 83 | 31 |
| 31 | 4583 | 2341 | 52 | 93 | 55 |
| 32 | 5374 | 5750 | 46 | 68 | 143 |
| 33 | 6371 | 8205 | 59 | 2 | 172 |

Source: Environmental Data Service [214]

## TABLE M-12

## WEATHER DATA FOR THE SERVICE AREAS OF FIRMS IN THE STRAIGHT ELECTRIC UTILITY SAMPLE (1969)

| Company Number | S/C | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ |
|---|---|---|---|---|---|---|
| 1 | 6204 | 3374 | 1991 | 56 | 76 | 66 |
| 2 | 9826 | 195 | 4142 | 60 | 70 | 0 |
| 3 | 8666 | 1002 | 3101 | 58 | 77 | 1 |
| 4 | 9726 | 1688 | 2496 | 59 | 42 | 12 |
| 5 | 10023 | 1002 | 3101 | 58 | 77 | 1 |
| 6 | 9500 | 5463 | 735 | 50 | 39 | 126 |
| 7 | 5173 | 6990 | 1001 | 58 | 17 | 129 |
| 8 | 8713 | 6617 | 757 | 66 | 7 | 139 |
| 9 | 6914 | 5064 | 1336 | 60 | 13 | 131 |
| 10 | 6549 | 5030 | 1558 | 50 | 50 | 118 |
| 11 | 8564 | 1709 | 2662 | 57 | 87 | 16 |
| 12 | 4473 | 7101 | 447 | 61 | 8 | 149 |
| 13 | 4082 | 5662 | 746 | 60 | 11 | 104 |
| 14 | 5563 | 6410 | 757 | 56 | 6 | 128 |
| 15 | 3568 | 9324 | 164 | 64 | 9 | 157 |
| 16 | 6127 | 5135 | 1534 | 62 | 35 | 110 |
| 17 | 4668 | 4458 | 1481 | 38 | 77 | 129 |
| 18 | 9029 | 4107 | 1264 | 54 | 15 | 104 |
| 19 | 8928 | 3824 | 1564 | 52 | 41 | 87 |
| 20 | 5334 | 6440 | 725 | 60 | 9 | 127 |
| 21 | 5682 | 6027 | 800 | 60 | 10 | 138 |
| 22 | 5750 | 6296 | 632 | 61 | 2 | 139 |
| 23 | 4677 | 6195 | 707 | 55 | 9 | 120 |
| 24 | 5789 | 6905 | 524 | 64 | 2 | 144 |
| 25 | 6459 | 5875 | 791 | 56 | 2 | 134 |
| 26 | 6218 | 6195 | 707 | 55 | 9 | 120 |
| 27 | 3558 | 5993 | 761 | 55 | 11 | 134 |
| 28 | 5207 | 7389 | 600 | 51 | 31 | 175 |
| 29 | 6964 | 931 | 3374 | 62 | 103 | 5 |
| 30 | 8332 | 2200 | 3000 | 54 | 103 | 22 |
| 31 | 5551 | 2668 | 2482 | 54 | 81 | 44 |
| 32 | 5904 | 5722 | 1050 | 46 | 59 | 135 |
| 33 | 7868 | 8484 | 420 | 64 | 2 | 170 |

Source: Environmental Data Service [214]

## TABLE M-13

## WEATHER DATA FOR THE SERVICE AREAS OF FIRMS IN THE COMBINATION UTILITY SAMPLE (1965)

| Company Number | S/C | $W_1$ | $W_3$ | $W_4$ | $W_5$ |
|---|---|---|---|---|---|
| 34 | 4870 | 1634 | 28 | 159 | 8 |
| 35 | 4450 | 3115 | 65 | 0 | 4 |
| 36 | 3800 | 1242 | 63 | 25 | 0 |
| 37 | 3560 | 5972 | 45 | 22 | 149 |
| 38 | 4550 | 6215 | 50 | 34 | 140 |
| 39 | 4420 | 6215 | 50 | 34 | 140 |
| 40 | 4650 | 6070 | 67 | 12 | 124 |
| 41 | 4240 | 7345 | 67 | 5 | 143 |
| 42 | 3840 | 6721 | 67 | 16 | 138 |
| 43 | 4030 | 6007 | 67 | 10 | 125 |
| 44 | 4170 | 4370 | 58 | 20 | 93 |
| 45 | 5950 | 1509 | 60 | 74 | 24 |
| 46 | 3790 | 4984 | 52 | 40 | 109 |
| 47 | 4820 | 6847 | 61 | 9 | 137 |
| 48 | 4450 | 8465 | 65 | 6 | 164 |
| 49 | 3600 | 4939 | 59 | 30 | 121 |
| 50 | 4800 | 4640 | 56 | 27 | 105 |
| 51 | 6290 | 5813 | 35 | 22 | 190 |
| 52 | 3210 | 5168 | 51 | 26 | 91 |
| 53 | 4330 | 7530 | 64 | 4 | 152 |
| 54 | 4340 | 7122 | 60 | 8 | 147 |
| 55 | 4560 | 4709 | 59 | 23 | 97 |
| 56 | 4810 | 5446 | 58 | 18 | 116 |
| 57 | 9860 | 4360 | 59 | 14 | 48 |
| 58 | 4250 | 5273 | 55 | 14 | 112 |
| 59 | 5480 | 3953 | 54 | 33 | 80 |
| 60 | 5570 | 7740 | 65 | 8 | 165 |
| 61 | 5250 | 7971 | 66 | 8 | 159 |

Source: Environmental Data Service [214]

## TABLE M-14

## WEATHER DATA FOR THE SERVICE AREAS OF FIRMS IN THE COMBINATION UTILITY SAMPLE (1967)

| Company Number | S/C | $W_1$ | $W_3$ | $W_4$ | $W_5$ |
|---|---|---|---|---|---|
| 34 | 5604 | 1488 | 31 | 155 | 18 |
| 35 | 5000 | 3000 | 66 | 0 | 0 |
| 36 | 4418 | 1347 | 60 | 8 | 0 |
| 37 | 3903 | 5918 | 42 | 4 | 172 |
| 38 | 5433 | 6310 | 54 | 9 | 131 |
| 39 | 5035 | 6310 | 54 | 9 | 131 |
| 40 | 5161 | 6262 | 63 | 8 | 123 |
| 41 | 4582 | 7455 | 62 | 4 | 148 |
| 42 | 4319 | 6529 | 61 | 12 | 141 |
| 43 | 4580 | 6204 | 65 | 2 | 125 |
| 44 | 4701 | 4420 | 58 | 13 | 88 |
| 45 | 6810 | 1576 | 59 | 64 | 24 |
| 46 | 4439 | 5042 | 55 | 17 | 103 |
| 47 | 5298 | 7335 | 61 | 0 | 114 |
| 48 | 4957 | 7609 | 58 | 17 | 115 |
| 49 | 4113 | 5124 | 62 | 26 | 118 |
| 50 | 5351 | 4814 | 60 | 17 | 95 |
| 51 | 6695 | 5840 | 47 | 61 | 188 |
| 52 | 3720 | 5302 | 56 | 7 | 89 |
| 53 | 4782 | 7509 | 66 | 0 | 152 |
| 54 | 4796 | 6852 | 59 | 0 | 130 |
| 55 | 5088 | 4988 | 60 | 17 | 101 |
| 56 | 5604 | 5707 | 60 | 8 | 115 |
| 57 | 10382 | 4378 | 73 | 21 | 35 |
| 58 | 4686 | 5193 | 55 | 12 | 99 |
| 59 | 6301 | 3850 | 56 | 18 | 75 |
| 60 | 5862 | 7927 | 61 | 2 | 180 |
| 61 | 5686 | 7609 | 58 | 17 | 155 |

Source: Environmental Data Service [214]

## TABLE M-15

## WEATHER DATA FOR THE SERVICE AREAS OF FIRMS IN THE COMBINATION UTILITY SAMPLE (1969)

| Company Number | S/C | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ |
|---|---|---|---|---|---|---|
| 34 | 6870 | 1337 | 3768 | 35 | 160 | 7 |
| 35 | 5550 | 2931 | 50 | 65 | 0 | 0 |
| 36 | 5030 | 1032 | 1279 | 65 | 14 | 0 |
| 37 | 4480 | 6109 | 721 | 46 | 34 | 165 |
| 38 | 6430 | 6348 | 725 | 56 | 13 | 141 |
| 39 | 5800 | 6348 | 725 | 56 | 13 | 141 |
| 40 | 6090 | 6484 | 893 | 62 | 8 | 147 |
| 41 | 5280 | 7632 | 633 | 65 | 4 | 162 |
| 42 | 5080 | 6872 | 989 | 62 | 16 | 141 |
| 43 | 5510 | 6543 | 913 | 64 | 7 | 144 |
| 44 | 5950 | 4764 | 1307 | 57 | 22 | 103 |
| 45 | 8600 | 1709 | 2662 | 57 | 87 | 16 |
| 46 | 5480 | 4707 | 1371 | 51 | 39 | 108 |
| 47 | 5950 | 7198 | 458 | 61 | 1 | 144 |
| 48 | 5750 | 8087 | 788 | 61 | 12 | 152 |
| 49 | 5030 | 5164 | 1556 | 60 | 49 | 117 |
| 50 | 6740 | 5110 | 1440 | 60 | 45 | 112 |
| 51 | 7420 | 5612 | 385 | 42 | 59 | 172 |
| 52 | 4430 | 5093 | 1169 | 53 | 15 | 104 |
| 53 | 5430 | 7381 | 384 | 66 | 0 | 140 |
| 54 | 5380 | 7016 | 624 | 60 | 66 | 146 |
| 55 | 6130 | 5316 | 1165 | 60 | 23 | 116 |
| 56 | 6690 | 5843 | 945 | 58 | 11 | 125 |
| 57 | 11450 | 4651 | 297 | 72 | 6 | 46 |
| 58 | 5540 | 5111 | 1128 | 54 | 9 | 114 |
| 59 | 7930 | 4080 | 1470 | 55 | 27 | 80 |
| 60 | 6350 | 7957 | 460 | 65 | 1 | 175 |
| 61 | 6380 | 7722 | 717 | 63 | 13 | 153 |

Source: Environmental Data Service [214]

### TABLE M-16

### PRICE, INCOME, ALL-ELECTRIC HOME, APPLIANCE STOCK INDEX, AND ADVERTISING DATA FOR THE FIRMS IN THE STRAIGHT ELECTRIC UTILITY SAMPLE (1965)

| Company Number | S/C | $P_2$ | $P_5$ | Y | E | $A_x$ | $P_4$ |
|---|---|---|---|---|---|---|---|
| 1 | 4140 | 7.92 | 11.70 | 1888 | .007 | .220 | 1.67 |
| 2 | 6580 | 6.93 | 11.05 | 2656 | .209 | .430 | 1.13 |
| 3 | 6010 | 9.58 | 14.16 | 2302 | .141 | .530 | .86 |
| 4 | 6440 | 7.11 | 10.61 | 2361 | .029 | .380 | 1.20 |
| 5 | 6920 | 7.85 | 12.44 | 2460 | .088 | .580 | 1.40 |
| 6 | 8280 | 7.28 | 9.95 | 2437 | .013 | .680 | 1.01 |
| 7 | 3870 | 7.50 | 9.98 | 3554 | .004 | .120 | 1.18 |
| 8 | 6680 | 7.15 | 9.22 | 2964 | .046 | .390 | 1.66 |
| 9 | 5070 | 9.50 | 12.40 | 2463 | .014 | .310 | .89 |
| 10 | 4790 | 5.42 | 7.92 | 2944 | .005 | .230 | 1.45 |
| 11 | 5620 | 7.15 | 10.42 | 2118 | .011 | .240 | 2.05 |
| 12 | 3580 | 8.93 | 11.88 | 2281 | .002 | .240 | .19 |
| 13 | 3090 | 9.68 | 13.44 | 3171 | .003 | .130 | .47 |
| 14 | 4260 | 7.74 | 7.61 | 3545 | .002 | .180 | 1.43 |
| 15 | 3100 | 7.79 | 10.92 | 2405 | .002 | .180 | 1.19 |
| 16 | 4400 | 8.05 | 11.00 | 3125 | .002 | .220 | 1.60 |
| 17 | 3700 | 7.18 | 9.78 | 2600 | .002 | .160 | 1.32 |
| 18 | 6620 | 6.75 | 9.00 | 2219 | .023 | .380 | 1.49 |
| 19 | 6120 | 6.36 | 9.44 | 2402 | .025 | .480 | 1.09 |
| 20 | 4200 | 7.16 | 11.06 | 3371 | .003 | .160 | 1.85 |
| 21 | 4240 | 7.70 | 11.49 | 2757 | .002 | .200 | 1.83 |
| 22 | 4510 | 6.87 | 10.12 | 2817 | .002 | .210 | 1.57 |
| 23 | 3650 | 6.85 | 9.25 | 2919 | .001 | .120 | 1.95 |
| 24 | 4800 | 7.36 | 10.61 | 2531 | .001 | .250 | 1.88 |
| 25 | 4990 | 7.55 | 9.73 | 2701 | .008 | .230 | 1.52 |
| 26 | 4850 | 7.45 | 10.43 | 2529 | .006 | .270 | 2.24 |
| 27 | 2550 | 8.51 | 11.51 | 2813 | .000 | .080 | .90 |
| 28 | 4460 | 8.72 | 10.92 | 2207 | .004 | .280 | 2.00 |
| 29 | 4730 | 8.22 | 10.47 | 2272 | .013 | .140 | 2.15 |
| 30 | 5160 | 7.62 | 9.59 | 2610 | .005 | .160 | 1.84 |
| 31 | 4110 | 8.04 | 10.67 | 2295 | .002 | .180 | 1.91 |
| 32 | 5070 | 7.11 | 9.26 | 2111 | .005 | .290 | 1.70 |
| 33 | 5220 | 7.49 | 11.11 | 2356 | .015 | .210 | .94 |

Sources: Price data from Federal Power Commission [223], income data from Office of Business Economics [215], all-electric home data from Federal Power Commission [219], appliance data from Billboard Publications, Statistical and Marketing Report [189], advertising expenditure data from Federal Power Commission [222].

## TABLE M-17

## PRICE, INCOME, ALL-ELECTRIC HOME, APPLIANCE STOCK INDEX, AND ADVERTISING DATA FOR THE FIRMS IN THE STRAIGHT ELECTRIC UTILITY SAMPLE (1967)

| Company Number | S/C | $P_2$ | $P_5$ | Y | E | $A_x$ | $P_4$ |
|---|---|---|---|---|---|---|---|
| 1 | 4686 | 7.47 | 9.60 | 2095 | .012 | .170 | 1.85 |
| 2 | 7712 | 6.80 | 10.84 | 3064 | .252 | .460 | 1.25 |
| 3 | 6747 | 9.26 | 13.91 | 2652 | .169 | .550 | 1.09 |
| 4 | 7651 | 6.92 | 10.38 | 2739 | .055 | .410 | 1.36 |
| 5 | 7843 | 7.72 | 11.84 | 2652 | .104 | .580 | 1.52 |
| 6 | 8780 | 7.28 | 9.95 | 2567 | .022 | .650 | 1.15 |
| 7 | 4391 | 7.52 | 9.96 | 4550 | .007 | .150 | 1.06 |
| 8 | 7517 | 6.97 | 9.22 | 3350 | .064 | .410 | 2.09 |
| 9 | 5886 | 9.50 | 12.40 | 2691 | .023 | .350 | 1.36 |
| 10 | 5175 | 5.25 | 7.75 | 3331 | .010 | .270 | 1.58 |
| 11 | 6700 | 7.09 | 10.29 | 2456 | .016 | .260 | 2.70 |
| 12 | 3976 | 8.96 | 11.93 | 2632 | .004 | .360 | .29 |
| 13 | 3588 | 9.48 | 12.90 | 3650 | .011 | .140 | 1.08 |
| 14 | 4794 | 7.74 | 7.61 | 3926 | .003 | .210 | 1.73 |
| 15 | 3349 | 7.79 | 10.92 | 2733 | .003 | .380 | 1.65 |
| 16 | 4848 | 7.89 | 10.85 | 3609 | .007 | .190 | 1.36 |
| 17 | 4073 | 7.18 | 9.78 | 2885 | .005 | .170 | 1.54 |
| 18 | 7455 | 6.75 | 9.00 | 2600 | .045 | .530 | 1.57 |
| 19 | 7258 | 6.36 | 9.44 | 2700 | .046 | .520 | 1.27 |
| 20 | 4661 | 6.10 | 10.35 | 3723 | .003 | .170 | 2.15 |
| 21 | 4732 | 7.38 | 11.17 | 3119 | .003 | .220 | 1.58 |
| 22 | 4978 | 7.36 | 10.61 | 3100 | .004 | .220 | 1.86 |
| 23 | 4066 | 6.85 | 9.25 | 3298 | .002 | .110 | 1.72 |
| 24 | 5295 | 7.36 | 10.61 | 2926 | .002 | .270 | 2.11 |
| 25 | 5324 | 7.55 | 9.73 | 2974 | .033 | .250 | 1.48 |
| 26 | 5452 | 7.15 | 9.45 | 2926 | .020 | .280 | 2.24 |
| 27 | 2984 | 8.41 | 11.41 | 3324 | .002 | .110 | 1.14 |
| 28 | 4714 | 8.72 | 10.92 | 2613 | .004 | .330 | 2.43 |
| 29 | 5630 | 8.22 | 10.47 | 2578 | .017 | .160 | 2.11 |
| 30 | 6060 | 7.62 | 9.59 | 3000 | .010 | .170 | 1.87 |
| 31 | 4583 | 8.50 | 11.15 | 2773 | .004 | .210 | 2.01 |
| 32 | 5374 | 7.11 | 9.26 | 2766 | .008 | .300 | 1.89 |
| 33 | 6371 | 7.35 | 10.97 | 2804 | .031 | .270 | 1.06 |

Sources: Price data from Federal Power Commission [223], income data from Office of Business Economics [215], all-electric home data from Federal Power Commission [219], appliance data from Billboard Publications, Statistical and Marketing Report [189], advertising expenditure data from Federal Power Commission [222].

## TABLE M-18

## PRICE, INCOME, ALL-ELECTRIC HOME, APPLIANCE STOCK INDEX, AND ADVERTISING DATA FOR THE FIRMS IN THE STRAIGHT ELECTRIC UTILITY SAMPLE (1969)

| Company Number | S/C | $P_2$ | $P_5$ | Y | E | $A_x$ | $P_4$ |
|---|---|---|---|---|---|---|---|
| 1 | 6204 | 7.42 | 9.81 | 2594 | .018 | .190 | 2.10 |
| 2 | 9826 | 6.80 | 10.83 | 3761 | .312 | .460 | 1.60 |
| 3 | 8666 | 8.88 | 12.94 | 3218 | .191 | .540 | .87 |
| 4 | 9726 | 7.02 | 10.56 | 3306 | .093 | .460 | 1.20 |
| 5 | 10023 | 7.57 | 11.55 | 3218 | .121 | .610 | 1.99 |
| 6 | 9500 | 7.88 | 9.95 | 2999 | .036 | .670 | 1.14 |
| 7 | 5173 | 8.04 | 10.49 | 4678 | .010 | .160 | 1.16 |
| 8 | 8713 | 6.97 | 9.22 | 3800 | .087 | .420 | 2.29 |
| 9 | 6914 | 9.50 | 12.40 | 3573 | .034 | .390 | 1.38 |
| 10 | 6549 | 5.42 | 7.92 | 3689 | .017 | .300 | 1.80 |
| 11 | 8564 | 7.09 | 10.29 | 2609 | .021 | .270 | 1.92 |
| 12 | 4473 | 8.63 | 11.68 | 3011 | .006 | .380 | .36 |
| 13 | 4082 | 9.50 | 12.81 | 4281 | .015 | .150 | 1.21 |
| 14 | 5563 | 7.74 | 6.84 | 4677 | .005 | .230 | 1.32 |
| 15 | 3568 | 7.31 | 10.92 | 3164 | .004 | .400 | 2.07 |
| 16 | 6127 | 8.15 | 11.24 | 4063 | .017 | .250 | 1.91 |
| 17 | 4668 | 7.52 | 9.22 | 3135 | .005 | .240 | 1.51 |
| 18 | 9020 | 6.75 | 9.00 | 2900 | .071 | .560 | 1.58 |
| 19 | 8928 | 6.36 | 99.44 | 2900 | .076 | .550 | 1.44 |
| 20 | 5334 | 7.04 | 10.39 | 4393 | .003 | .170 | 1.91 |
| 21 | 5682 | 7.12 | 11.62 | 3704 | .005 | .290 | 1.61 |
| 22 | 3750 | 6.87 | 10.12 | 3674 | .006 | .230 | 2.36 |
| 23 | 4677 | 6.85 | 9.25 | 3807 | .004 | .130 | 1.71 |
| 24 | 5789 | 6.36 | 10.61 | 3323 | .003 | .300 | 2.39 |
| 25 | 6459 | 7.55 | 9.73 | 3500 | .046 | .300 | 1.30 |
| 26 | 6218 | 7.05 | 9.30 | 3323 | .040 | .310 | 2.15 |
| 27 | 3558 | 8.33 | 10.83 | 3700 | .005 | .150 | 1.59 |
| 28 | 5207 | 8.72 | 10.92 | 2986 | .007 | .340 | 2.34 |
| 29 | 6964 | 8.22 | 10.47 | 2959 | .026 | .180 | 2.08 |
| 30 | 8332 | 8.06 | 10.03 | 3500 | .021 | .210 | 1.94 |
| 31 | 5551 | 8.19 | 10.91 | 3249 | .007 | .230 | 2.13 |
| 32 | 5904 | 7.11 | 9.26 | 2991 | .011 | .330 | 1.93 |
| 33 | 7868 | 7.35 | 10.97 | 3262 | .058 | .330 | 1.00 |

Sources: Price data from Federal Power Commission [223], income data from Office of Business Economics [215], all-electric home data from Federal Power Commission [219], appliance data from Billboard Publications, Statistical and Marketing Report [189], advertising expenditure data from Federal Power Commission [222].

## TABLE M-19

## PRICE, INCOME, ALL-ELECTRIC HOME, APPLIANCE STOCK INDEX, AND ADVERTISING DATA FOR THE FIRMS IN THE COMBINATION UTILITY SAMPLE (1965)

| Company Number | S/C | $P_2$ | $P_5$ | Y | E | $A_x$ | $P_4$ |
|---|---|---|---|---|---|---|---|
| 34 | 4870 | 7.80 | 11.18 | 2550 | .041 | .130 | 1.37 |
| 35 | 4450 | 6.20 | 9.40 | 3361 | .020 | .170 | .74 |
| 36 | 3800 | 6.56 | 9.19 | 3514 | .039 | .130 | 1.78 |
| 37 | 3560 | 7.12 | 9.62 | 2883 | .001 | .180 | 1.23 |
| 38 | 4550 | 8.35 | 12.13 | 3432 | .005 | .260 | 1.56 |
| 39 | 4420 | 8.25 | 10.75 | 3492 | .005 | .190 | 1.73 |
| 40 | 4650 | 7.64 | 10.56 | 3200 | .001 | .250 | .58 |
| 41 | 4240 | 7.95 | 11.08 | 2580 | .002 | .310 | 1.03 |
| 42 | 3840 | 7.39 | 11.13 | 2760 | .000 | .160 | .75 |
| 43 | 4030 | 8.52 | 11.65 | 2700 | .000 | .360 | .53 |
| 44 | 4170 | 5.90 | 8.65 | 2853 | .001 | .090 | .32 |
| 45 | 5950 | 8.08 | 10.06 | 2526 | .020 | .220 | 2.40 |
| 46 | 3790 | 8.05 | 12.48 | 2862 | .004 | .160 | .99 |
| 47 | 4820 | 6.92 | 8.97 | 3039 | .003 | .290 | .98 |
| 48 | 4450 | 7.11 | 10.15 | 3295 | .002 | .240 | 2.56 |
| 49 | 3600 | 8.21 | 10.48 | 2575 | .001 | .230 | 1.23 |
| 50 | 4800 | 7.25 | 10.37 | 3148 | .007 | .200 | 1.05 |
| 51 | 6290 | 9.23 | 12.98 | 3238 | .000 | .550 | 2.07 |
| 52 | 3210 | 7.32 | 10.15 | 3568 | .001 | .130 | .94 |
| 53 | 4330 | 8.10 | 11.65 | 2738 | .002 | .200 | .61 |
| 54 | 4340 | 7.17 | 11.02 | 2841 | .003 | .300 | .83 |
| 55 | 4560 | 7.12 | 10.64 | 2874 | .004 | .200 | 1.06 |
| 56 | 4810 | 7.19 | 10.39 | 3023 | .005 | .270 | 1.55 |
| 57 | 9860 | 5.35 | 6.40 | 2771 | .140 | .620 | 2.65 |
| 58 | 4250 | 6.48 | 8.98 | 3034 | .003 | .190 | 1.42 |
| 59 | 5480 | 7.40 | 10.30 | 2750 | .012 | .260 | 1.88 |
| 60 | 5570 | 4.85 | 7.60 | 2817 | .000 | .170 | .26 |
| 61 | 5250 | 7.03 | 10.15 | 2677 | .000 | .360 | .64 |

Sources: Price data from Federal Power Commission [223], income data from Office of Business Economics [215], all-electric home data from Federal Power Commission [219], appliance data from Billboard Publications, Statistical and Marketing Report [189], advertising expenditure data from Federal Power Commission [222].

## TABLE M-20

### PRICE, INCOME, ALL-ELECTRIC HOME, APPLIANCE STOCK INDEX, AND ADVERTISING DATA FOR THE FIRMS IN THE COMBINATION UTILITY SAMPLE (1967)

| Company Number | S/C | $P_2$ | $P_5$ | Y | E | $A_x$ | $P_4$ |
|---|---|---|---|---|---|---|---|
| 34 | 5604 | 7.83 | 11.23 | 2899 | .043 | .140 | 2.11 |
| 35 | 5000 | 6.65 | 9.85 | 3730 | .030 | .170 | .74 |
| 36 | 4418 | 6.56 | 9.19 | 4028 | .046 | .160 | 1.80 |
| 37 | 3903 | 7.53 | 10.03 | 3313 | .001 | .180 | 1.35 |
| 38 | 5433 | 8.13 | 12.38 | 3978 | .016 | .290 | 1.84 |
| 39 | 5038 | 8.25 | 10.50 | 4119 | .011 | .210 | 1.83 |
| 40 | 5161 | 7.70 | 10.65 | 3500 | .002 | .260 | .85 |
| 41 | 4582 | 7.95 | 11.08 | 2823 | .003 | .330 | 2.03 |
| 42 | 4319 | 8.36 | 12.08 | 3087 | .000 | .200 | .36 |
| 43 | 4580 | 8.52 | 11.65 | 3000 | .000 | .230 | .67 |
| 44 | 4701 | 5.90 | 8.65 | 3225 | .002 | .120 | .33 |
| 45 | 6810 | 8.09 | 10.07 | 2991 | .033 | .240 | 2.26 |
| 46 | 4439 | 7.96 | 12.39 | 3280 | .007 | .170 | 1.26 |
| 47 | 5298 | 6.84 | 8.94 | 3387 | .005 | .320 | .97 |
| 48 | 4957 | 7.11 | 10.15 | 3824 | .002 | .280 | 2.55 |
| 49 | 4113 | 8.21 | 10.71 | 2901 | .002 | .250 | 1.34 |
| 50 | 5351 | 7.25 | 10.37 | 3588 | .014 | .200 | 1.15 |
| 51 | 6695 | 8.98 | 11.83 | 3649 | .007 | .540 | 1.61 |
| 52 | 3720 | 7.32 | 10.18 | 4094 | .001 | .160 | .60 |
| 53 | 4782 | 7.48 | 11.01 | 3104 | .005 | .210 | .63 |
| 54 | 4796 | 7.17 | 11.02 | 3212 | .005 | .260 | .83 |
| 55 | 5088 | 7.15 | 10.72 | 3329 | .004 | .280 | 1.13 |
| 56 | 5604 | 7.23 | 10.47 | 3445 | .012 | .290 | 1.73 |
| 57 | 10382 | 6.85 | 8.57 | 3090 | .171 | .640 | 2.41 |
| 58 | 4686 | 6.48 | 8.98 | 3513 | .001 | .220 | 1.44 |
| 59 | 6301 | 7.40 | 10.30 | 2801 | .027 | .290 | 2.21 |
| 60 | 5862 | 4.85 | 7.60 | 3202 | .000 | .190 | .31 |
| 61 | 5686 | 6.70 | 10.20 | 3001 | .000 | .360 | .86 |

Source: Price data from Federal Power Commission [223], income data from Office of Business Economics [215], all-electric home data from Federal Power Commission [219], appliance data from Billboard Publications, Statistical and Marketing Report [189], advertising expenditure data from Federal Power Commission [222].

## TABLE M-21

## PRICE, INCOME, ALL-ELECTRIC HOME, APPLIANCE STOCK INDEX, AND ADVERTISING DATA FOR THE FIRMS IN THE COMBINATION UTILITY SAMPLE (1969)

| Company Number | S/C | $P_2$ | $P_5$ | Y | E | $A_x$ | $P_4$ |
|---|---|---|---|---|---|---|---|
| 34 | 6870 | 7.95 | 11.35 | 3498 | .043 | .150 | 3.16 |
| 35 | 5550 | 6.20 | 9.40 | 4394 | .032 | .170 | .59 |
| 36 | 5030 | 6.56 | 9.19 | 4728 | .049 | .180 | 2.19 |
| 37 | 4480 | 7.12 | 9.62 | 3889 | .001 | .200 | 1.29 |
| 38 | 6430 | 8.13 | 12.38 | 4595 | .032 | .270 | 1.77 |
| 39 | 5800 | 8.25 | 10.50 | 4755 | .019 | .240 | 2.98 |
| 40 | 6090 | 8.22 | 11.37 | 4012 | .005 | .260 | .94 |
| 41 | 5280 | 7.95 | 11.08 | 3336 | .004 | .340 | 1.66 |
| 42 | 5080 | 7.42 | 11.20 | 3519 | .001 | .340 | .50 |
| 43 | 5510 | 8.30 | 11.43 | 3500 | .001 | .300 | .66 |
| 44 | 5950 | 5.90 | 8.65 | 3812 | .033 | .230 | .34 |
| 45 | 8600 | 8.09 | 10.06 | 3441 | .040 | .270 | 2.02 |
| 46 | 5480 | 8.06 | 12.59 | 3856 | .011 | .200 | 1.24 |
| 47 | 5950 | 6.84 | 8.94 | 3987 | .011 | .330 | .96 |
| 48 | 5750 | 7.66 | 10.71 | 4419 | .004 | .330 | 2.42 |
| 49 | 5030 | 8.21 | 10.71 | 3366 | .003 | .250 | 1.32 |
| 50 | 6740 | 7.33 | 10.49 | 3993 | .008 | .210 | 1.26 |
| 51 | 7420 | 8.98 | 11.83 | 4244 | .026 | .560 | 1.97 |
| 52 | 4430 | 7.35 | 10.35 | 4735 | .005 | .170 | .73 |
| 53 | 5430 | 7.84 | 11.26 | 3616 | .010 | .220 | .66 |
| 54 | 5380 | 6.80 | 10.57 | 3746 | .008 | .290 | .87 |
| 55 | 6130 | 7.28 | 10.98 | 3925 | .005 | .290 | 1.51 |
| 56 | 6690 | 7.28 | 10.11 | 4104 | .023 | .290 | 2.09 |
| 57 | 11450 | 5.35 | 6.40 | 3521 | .181 | .560 | 2.57 |
| 58 | 5540 | 6.48 | 8.98 | 4028 | .003 | .240 | 1.23 |
| 59 | 7930 | 7.40 | 10.30 | 3687 | .042 | .320 | 2.34 |
| 60 | 6350 | 5.41 | 8.16 | 3614 | .000 | .210 | .27 |
| 61 | 6380 | 6.70 | 10.20 | 3512 | .000 | .390 | .77 |

Source: Price data from Federal Power Commission [223], income data from Office of Business Economics [215], all-electric home data from Federal Power Commission [219], appliance data from Billboard Publications, *Statistical and Marketing Report* [189], advertising expenditure data from Federal Power Commission [222].

## APPENDIX N

## PRELIMINARY ANALYSIS OF CROSS-SECTIONAL DATA

Sources of data for the cross-sectional analysis are discussed in Appendix L. The firms included in the cross-sectional sample are presented in Appendix J. Finally, data for the firms in the sample are presented in Appendix M. The discussion in Appendix L suggested that there was some choice as to the specific data series which might be used to represent the various determinants of the residential demand for electricity. In this Appendix these alternative data series will be tested statistically to determine which of them will be included in the final version of the cross-sectional model. In addition, discussion of the variation in each of the chosen data series is included in this section. This discussion includes some consideration of the variation in each of the independent variable data series versus the variation in the dependent variable data series.

The following notation is used to identify the different samples:

1969 SE -- 1969 straight electric utility sample
1969 C -- 1969 combination utility sample
1967 SE -- 1967 straight electric utility sample
1967 C -- 1967 combination utility sample
1965 SE -- 1965 straight electric utility sample
1965 C -- 1965 combination utility sample

## Per Customer Kilowatt Hour Sales

Average per customer sales data are presented in Table N-1. Comparing the per customer kilowatt hour sales of the straight electric utilities with those of the combination utilities shows that average straight electric utility sold more electricity per residential customer than the average combination utility in each of the three years. This is in keeping with Brandon's findings, quoted earlier, and provides some justification for dividing privately owned electric utilities into straight electric and combination utility subgroups [34].

Comparing the per customer kilowatt hour sales data for the firms in the sample (Table N-1) with the per customer kilowatt hour sales for the total privately owned electric utility industry indicated that the firms in the sample are representative of the industry in regard to kilowatt hour sales per customer. This comparison provides some measure of the overall representativeness of the firms in the sample.

It is interesting to note that per customer kilowatt hour sales of the average straight electric utility in the sample increased by 36 percent between 1965 and 1969 while the comparable figure for the average combination utility in the sample was only 26 percent. This outcome is consistent with Brandon's conclusion that combination utilities "induce less consumption of electric energy" [34, pp. 702-703]. This finding also provides further evidence to justify treating combination and straight electric utilities separately.

## TABLE N-1

## AVERAGE PER CUSTOMER KILOWATT HOUR SALES FOR THE UTILITIES IN THE SIX SAMPLES

| Sample | Average Kilowatt Hour Sales | Highest Kilowatt Hour Sales | Lowest Kilowatt Hour Sales |
|---|---|---|---|
| 1969 SE | 6654 | 10023 | 3558 |
| 1969 C | 6169 | 11450 | 4430 |
| 1967 SE | 5534 | 8780 | 2984 |
| 1967 C | 5260 | 10382 | 3720 |
| 1965 SE | 4891 | 8280 | 2550 |
| 1965 C | 4712 | 9860 | 3210 |

Source: Federal Power Commission [222]

Finally, Table N-1 shows that per customer kilowatt hour sales vary significantly between the utilities in a given sample. The average straight electric utility sold 6654 kilowatt hours of electricity to the average residential customer in 1969. However, one straight electric utility sold as little as 3558 kilowatt hours per residential customer while another straight electric utility sold over 10,000 kilowatt hours per residential customer in that same year. It is hypothesized that the independent variables in the model will explain this substantial variation.

### Weather Variables

The role of weather in determining the residential demand for electricity was discussed in Chapter III. The Federal Power Commission has singled out electric heating and air conditioning as "weather-sensitive loads" [222, p. I-3-12]. John W. Wilson has made similar observations [240, p. 12].

Five weather variables were selected earlier for possible inclusion in the model. These variables and the symbols used to identify them are listed below:

$W_1$ = heating degree days

$W_2$ = cooling degree days

$W_3$ = average relative humidity

$W_4$ = number of days with a maximum temperature of more than 90 degrees fahrenheit

$W_5$ = number of days with a minimum temperature of less than 32 degrees fahrenheit

The number of heating degree days, the number of cooling degree days, the average relative humidity, the number of days with a maximum temperature greater than 90 degrees, and the number of days with a minimum temperature of less than 32 degrees experienced in the service area of the average utility in each of the six samples are shown in Table N-2.

The data in Table N-2 show that straight electric utilities operate in areas that are warmer, on the average, than those areas in which combination utilities operate. Comparisons for each of the three years show that the average straight electric utility faced fewer heating degree days and more cooling degree days than the average combination utility. These comparisons also show that the average straight electric utility faced more days with a maximum temperature of 90 degrees or more and fewer days with a minimum temperature of 32 degrees or less. The fact that there is a heavier concentration of combination utilities in the colder regions of the country is perhaps not coincidental. Wilson has argued that for home heating electricity has the advantage over gas in warm areas and that gas has the advantage over electricity in cold areas [240, p. 16]:

> . . . in cold climates where the cost of home heating is large, operating costs (fuel) dominate consumption decisions, whereas in warm climates where variable costs are much lower, home owners are more influenced by fixed cost considerations, and there electricity has the advantage.

TABLE N-2

AVERAGE WEATHER DATA FOR
THE SIX SAMPLES

| Sample | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ |
|---|---|---|---|---|---|
| 1969 SE | 4872 | 1437 | .57 | 34 | 104 |
| 1969 C | 5506 | 1036 | .58 | 25 | 113 |
| 1967 SE | 4695 | N.A.* | .57 | 28 | 96 |
| 1967 C | 5424 | N.A. | .58 | 9 | 107 |
| 1965 SE | 4608 | N.A. | .57 | 32 | 95 |
| 1965 C | 5406 | N.A. | .57 | 25 | 110 |

*N.A. -- Not Available

Source: Environmental Data Service [214]

The above discussion suggests an explanation for the heavier concentration of combination utilities in the colder regions of the country.

Electricity is not competitive with gas for the home heating segment of the market in cold regions of the country. If electric utilities which operate in cold regions are to effectively compete for the home heating segment of the market they must sell gas as well as electricity. Utilities which operate in warmer regions do not have this incentive to sell gas.

Simple correlations were run between the five weather variables and per capita kilowatt hour sales using 1969 data for both combination and straight electric utilities to determine which of the five weather variables was or were the best predictors of per customer kilowatt hour sales. The simple correlation coefficients are shown in Table N-3.

TABLE N-3

SIMPLE CORRELATIONS BETWEEN THE FIVE WEATHER VARIABLES AND PER CUSTOMER KILOWATT HOUR SALES (S/C) (1969)

| | S/C | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ |
|---|---|---|---|---|---|---|
| S/C | 1.00 | | | | | |
| $W_1$ | - .63 | 1.00 | | | | |
| $W_2$ | .60 | - .96 | 1.00 | | | |
| $W_3$ | .05 | .14 | - .04 | 1.00 | | |
| $W_4$ | .40 | - .82 | .85 | - .35 | 1.00 | |
| $W_5$ | - .60 | .96 | - .95 | - .01 | - .79 | 1.00 |

The correlation coefficients in Table N-3 show that heating degree days ($W_1$) and cooling degree days ($W_2$) are more heavily associated with per customer kilowatt hour sales than any of the other weather variables. This is understandable when one considers that heating degree days ($W_1$) are a finer measure of cold weather than are the number of days with a minimum temperature of 32 degrees or less ($W_2$). Heating degree days ($W_1$) are a better measure of the need for home heating for several reasons.

1. Heating degree days ($W_1$) are accumulated for any day that has an average temperature of less than 65 degrees whereas days under 32 degrees ($W_5$) are only accumulated for days that have minimum temperature of less than 32 degrees. In other words, days under 32 degrees ($W_5$) are not accumulated for many days when residential consumers are actually using their heaters -- days that have a minimum temperature between 65 and 32 degrees.
2. Days under 32 degrees ($W_5$) are a yes or no proposition, a particular day has a minimum temperature of less than 32 degrees or it does not. Heating degree days ($W_1$) is also a yes or no proposition in the sense that heating degree days are only accumulated if the average temperature for the day is less than 65 degrees. However, heating degree days also indicate the difference between 65 and a day's average temperature.
3. Heating degree days ($W_1$) are computed on the basis of a day's average temperature while days under 32 are based on a day's minimum temperature.

For the above reasons, heating degree days are the best measure of the need for home heating. Based on a similar line of reasoning, cooling degree days ($W_2$) are the best measure of the need for home cooling.

It was suggested earlier that humidity ($W_3$) might be a significant determinant of the demand for electricity for both home heating and home cooling. The simple correlation between per customer sales (S/C) and average relative humidity ($W_3$), shown in Table N-3, is extremely weak and does not even approach statistical significance. This lack of association is understandable when the variation in average relative humidity ($W_3$) is considered in relation to the variation in per customer kilowatt hour sales (S/C). The average relative humidity ($W_3$) for the firms in the straight electric utility sample in 1969 was 57 percent with a standard deviation of 5.6 percent. This means that 68 percent of the service areas of the firms in this sample have average relative humidities of from 51.4 to 62.6 percent. In other words, 68 percent of the cases fall within ± 10 percent of the mean value of relative humidity. Looking again at the 1969 straight electric sample, one must go 30 percent on either side of the mean per capita sales value to encompass 68 percent of the firms in the sample. The conclusion of this sample analysis is that there is not enough variation in the average relative humidity data to explain the between utility variation in per customer sales. This is not to say that very high humidity levels and very low humidity levels do not influence the demand for home heating and home cooling. It does mean that average relative humidity falls in a fairly narrow range for most utilities in the sample while their per customer sales vary over a much wider range. Average relative humidity ($W_3$) was, therefore, dropped from the analysis because it is not a significant explanatory variable. Differences in humidity ($W_3$) do not explain the differences in per customer sales between utility firms.

It was noted, in Table N-3, that cooling degree day ($W_2$) information is not available for the years 1965 and 1967. This lack of data presented a problem because if comparable regression results are to be obtained, the same variables must be used in all three years. A solution to this problem was found by examining the simple correlation coefficients in Table N-3. The correlation between heating degree days ($W_1$) and cooling degree days ($W_2$), shown in Table N-3, is -.96. This indicates the existence of an almost perfect inverse relationship between heating degree days ($W_1$) and cooling degree days ($W_2$). This finding seems reasonable because areas which are very hot in the summer tend to be relatively warm in the winter and areas which are fairly cool in the summer tend to be relatively cold in the winter. Areas with a high number of heating degree days ($W_1$) tend to have a low number of cooling degree days. One can accurately predict the number of cooling degree days ($W_2$) experienced in an area from the number of heating degree days ($W_1$) experienced in that area.

Based on the above analysis, heating degree days ($W_1$) was chosen as the appropriate measure of those weather conditions which affect the residential demand for electric power.

## Per Customer Appliance Stock Index

The computation of this index is discussed in Appendix H. The index is based on the per customer ownership of seven high consumption electrical appliances. These appliances and the symbols used to identify them are listed below:

$A_1$ = water heaters per customer

$A_2$ = room air conditioners per customer

$A_3$ = home freezers per customer

$A_4$ = electric ranges per customer

$A_5$ = electric clothes dryers per customer

$A_6$ = dishwashers per customer

$A_7$ = clothes washers per customer

Per customer ownership data for these seven appliances in the market areas of the average firm in each of the six samples are shown in Table N-4.

TABLE N-4

AVERAGE PER CUSTOMER OWNERSHIP OF MAJOR ELECTRICAL APPLIANCES

| Sample | $A_1$ | $A_2$ | $A_3$ | $A_4$ | $A_5$ | $A_6$ | $A_7$ |
|---|---|---|---|---|---|---|---|
| 1969 SE | .31 | .26 | .29 | .54 | .33 | .15 | .67 |
| 1969 C | .23 | .25 | .29 | .45 | .32 | .18 | .61 |
| 1967 SE | .29 | .21 | .26 | .52 | .28 | .13 | .64 |
| 1967 C | .22 | .21 | .29 | .43 | .27 | .14 | .60 |
| 1965 SE | .26 | .22 | .23 | .49 | .25 | .10 | .60 |
| 1965 C | .22 | .18 | .27 | .40 | .23 | .12 | .55 |

Source: Merchandising Week [189]

The data in Table N-4 show that the general trend in electrical appliance ownership is moving upwards. Table N-4 also shows that per customer appliance ownership is higher, on the average, in the service areas of straight electric utility firms. This conclusion holds true in regard to all of the seven major appliances with the exception of electric dishwashers ($A_6$). For some inexplicable reason the per customer ownership of electric dishwashers is higher, but not significantly higher, in the service areas of the average combination utility in all three years. The higher per customer ownership of electrical appliances in the service areas of straight electric utilities seems reasonable in the light of Brandon's findings, cited earlier [34]. The higher per customer ownership of electrical appliances in the service areas of straight electric utilities also makes sense when we consider the fact that straight electric utilities encourage the use of electrical appliances only, while combination utilities encourage the use of both gas and electrical appliances. It is interesting to note that the greatest differentials in per customer appliance ownership between straight electric and combination utilities occur in the cases of electric water heaters and electric ranges and that these are also the two uses (water heating and cooking) for which gas is most competitive with electricity [72, p. 106].

Finally, it should be noted that the per customer appliance ownership data for the firms in the sample (Table N-4) are in line with the per customer appliance ownership data for the total privately owned electric utility industry (see Chapter IV). This provides further evidence of the representativeness of the sample.

Average appliance stock index ($A_x$) data for the six samples are shown in Table N-5. The data in this table confirm the earlier conclusion that the average customer of the average straight electric utility has more high consumption electrical appliances than does the average customer of the average combination utility.

## TABLE N-5

## AVERAGE PER CUSTOMER APPLIANCE STOCK INDEX FOR UTILITIES IN THE SIX SAMPLES

| Sample | Average Appliance Stock Index |
|---|---|
| 1969 SE | .317 |
| 1969 C | .275 |
| 1967 SE | .298 |
| 1967 C | .257 |
| 1965 SE | .262 |
| 1965 C | .244 |

Source: Computed on the basis of data obtained from Merchandising Week [189] and from the Federal Power Commission [224].

The appliance stock index ($A_x$), to refresh the reader's memory, is a weighted average of the per customer ownership figures for the seven appliances listed in Table N-4. The weighting factors for each appliance was that appliance's annual average kilowatt hour consumption. The index is constructed so that it has an upper limit of unity and a lower limit of zero. The upper limit is achieved if every customer owns the seven major appliances. The data in Table N-5 show that in 1969, for example, the average customer of the average straight electric utility had a stock of electric appliances which had an electricity consumption potential equal to 32 percent of the electricity consumption potential for the home which owned all seven of the major electrical appliances. This was the highest appliance stock index achieved in any of the samples. Note, again, that the appliance stock index for the average customer of the average straight electric utility is higher than the appliance stock index for the average customer of the average combination utility in 1965, 1967 and 1969. This finding would be expected, given the earlier findings in regard to the per customer ownership of the seven major appliances (see Table N-4).

In Chapters III and IV it was argued that the residential demand for electric power is a derived demand. A demand largely determined by the residential stock of electrical appliances and electricity consuming devices. One would therefore expect that other things equal the higher the appliance stock index for a particular area the higher the per customer consumption of electricity in that area. Comparison of the data in Table N-4 with data in Table N-5 provides some evidence to support this hypothesis. The data in Table N-5 show that the average customer of the average straight electric utility had a larger stock of electrical appliances than did the average customer of the average combination utility in each of the three years. The data in Table N-4 show that the average customer of the average straight electric utility also used more electricity than did the average customer of the average combination utility in each of the three years.

Simple correlations between the average appliance stock index and average per customer kilowatt hour sales for each firm were calculated for each sample as a preliminary statistical test of the derived demand hypothesis. These correlations are shown in Table N-6.

The correlations shown in Table N-6 provide further evidence for the hypothesis that the residential demand for electricity is a derived

TABLE N-6

SIMPLE CORRELATIONS BETWEEN PER CUSTOMER SALES (S/C) AND THE APPLIANCE STOCK INDEX ($A_x$) FOR THE FIRMS IN THE SIX SAMPLES

| Sample | Simple Correlations |
|---|---|
| 1969 SE | .76 |
| 1969 C | .61 |
| 1967 SE | .81 |
| 1967 C | .76 |
| 1965 SE | .89 |
| 1965 C | .75 |

demand. The correlations are robust and positive. The positive signs indicate that per customer sales are higher in those areas where the appliance stock index is higher.

## All-Electric Homes

Earlier in this dissertation it was argued, with some authority, that the residential demand for electricity is a derived demand [72,240]. A demand derived from the residential stock of electrical appliances and electricity consuming devices. In the immediately preceeding section, evidence was presented which tended to confirm the hypothesis that the residential stock of electrical appliances is an important determinant of residential electricity sales.

It would seem that there are other devices, used in the home besides those normally considered to be appliances, which consume electricity and could reasonably be expected to have an influence on the demand for electricity. Foremost among this group of other electricity consuming devices are electric heaters and air conditioners.[1] The impossibility of assembling data on the total number of homes, in the service areas of the firms in the six samples, which have central electric heating and air conditioning was discussed in Appendix L. As a substitute for the total number of central heating and cooling systems, data were collected on the number of all-electric homes with such systems [219]. These data would, of course, underestimate the total number of central heating and air conditioning systems in service in a particular firm's market area in that they omit those homes which have central electric heating and cooling but are not all-electric.[2] It would obviously be more desirable to have data on the total number of central electric heating and cooling systems in service in a particular area. However, as noted earlier, these data are not available.

Data on the number of all-electric homes with central electric heating and cooling in the service areas of the individual utilities in the sample were obtained from All-Electric Homes in the United States [219]. The total number of all-electric homes with central electric heating and cooling in a particular firm's service area were divided by the total number of customers served by that firm to arrive at the measure all-electric homes with central heat and air conditioning per customer. The data were converted to a per customer basis to fit the form of the dependent variable per customer kilowatt hour sales.

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[1] This discussion applies to central air conditioners. Room air conditioners were considered in the section on appliances.

[2] A home must use electricity as the sole source of energy to be classified as all-electric [219, p.1].

## TABLE N-7

## ALL ELECTRIC HOMES PER CUSTOMER FOR THE FIRMS IN THE SIX SAMPLES

| Sample | All-Electric Homes Per Customer |
|---|---|
| 1969 SE | .041 |
| 1969 C | .020 |
| 1967 SE | .021 |
| 1967 C | .016 |
| 1965 SE | .016 |
| 1965 C | .011 |

Source: Federal Power Commission [219]

Table N-7 shows the average number of all electric homes with central heat and air conditioning for the firms in the six samples. This table shows, for example, that in 1969, 4.1 percent of the residential customers of the average straight electric utility were all-electric customers with central air conditioning and heating. This table also shows a gradual increase in the percentage of all-electric customers for both the average straight electric and combination utility firm.

Finally, this table shows that the average straight electric utility firm has a higher proportion of all-electric customers with central heating and air conditioning than does the average combination utility. In 1969 the average straight electric utility had, in relative terms, twice as many all-electric residential customers as the average combination utility. This would again be expected given the motivation of straight electric utilities to sell electricity only and the motivation of combination utilities to sell both gas and electricity.

It would seem reasonable to hypothesize that the average all-electric home would tend to use more electricity than the home which uses a combination of energy sources. In fact, in 1969 the average all-electric home consumed 20,580 kilowatt hours of electricity while the average home used only 6,246 kilowatt hours of electricity. It would also seem reasonable to assume that, other things equal, utilities with larger relative numbers of all-electric customers would tend to enjoy higher average per customer kilowatt hour sales. To test this hypothesis simple correlations between per customer kilowatt hour sales and the number of all-electric homes per customer for the firms in each of the samples were computed. The calculated correlation coefficients are shown in Table N-8.

The coefficients in Table N-8 tend to confirm the hypothesis that there is a positive and statistically significant relationship between per customer kilowatt hour sales (S/C) and the number of all-electric homes per customer (E). In other words, those areas with a larger relative number of all-electric homes tend to enjoy higher per customer sales of electricity. The number of all-electric homes per customer (E) would therefore appear to be an important determinant of residential electricity consumption.

### TABLE N-8

### SIMPLE CORRELATIONS BETWEEN PER CUSTOMER SALES (S/C) AND THE NUMBER OF ALL-ELECTRIC HOMES PER CUSTOMER (E) FOR THE SIX SAMPLES

| Sample | Simple Correlations |
|---|---|
| 1969 SE | .68 |
| 1969 C | .82 |
| 1967 SE | .58 |
| 1967 C | .82 |
| 1965 SE | .51 |
| 1965 C | .77 |

## Price and Income Variables

The discussion in Chapter III provided some authority for the hypotheses that both consumer income and the price of electricity are significant determinants of electricity sales. The empirical results presented in Chapter IV provided some support for these hypotheses. In this section some simple comparisons will be made between the average prices charged by different utilities for 500 kilowatt hours of electricity and their average per customer kilowatt hour sales. Comparisons will also be made between per capita personal income in the service areas of different utilities and the per customer kilowatt hour sales of those utilities. Reasons for using the particular price and income series were discussed in Appendix L. Average price and income data for the firms in each of the six samples are shown in Table N-9.

## TABLE N-9

## AVERAGE PRICE AND INCOME DATA FOR THE SIX SAMPLES (In Current Dollars)

| Sample | Per Capita Income | Price of 500 Kilowatt Hours |
|---|---|---|
| 1969 SE | 3453 | 10.35 |
| 1969 C | 3923 | 10.32 |
| 1967 SE | 2979 | 10.41 |
| 1967 C | 3361 | 10.39 |
| 1965 SE | 2624 | 10.57 |
| 1965 C | 2967 | 10.29 |

Sources: Price data [223], income data [215]

The data in Table N-9 show that combination utilities serve areas which, on the average, have higher per capita personal incomes than those areas served by straight electric utilities. The data in Table N-9 also show that prices charged by combination utilities are on the average lower than those charged by straight electric utilities. Finally, the price data in Table N-9 show the remarkable stability of electricity prices.

Simple correlations were run between the prices charged by firms and their per customer sales and between per capita income in the service areas of the firms in the sample and their per customer kilowatt hour sales. These correlations are shown in Table N-10.

## TABLE N-10

## SIMPLE CORRELATIONS BETWEEN PER CUSTOMER SALES AND THE PRICE OF 500 KILOWATT HOURS, AND BETWEEN PER CUSTOMER SALES AND PER CAPITA PERSONAL INCOME FOR THE FIRMS IN EACH OF THE SIX SAMPLES

| Sample | Correlations Between Income And Per Customer Sales | Correlations Between Price And Per Customer Sales |
|---|---|---|
| 1969 SE | - .32 | - .03 |
| 1969 C | - .26 | - .39 |
| 1967 SE | - .37 | - .08 |
| 1967 C | - .21 | - .27 |
| 1965 SE | - .30 | - .12 |
| 1965 C | - .20 | - .43 |

The correlations in Table N-10 show that the relationship between the price of 500 kilowatt hours and per customer sales is consistently negative or inverse. In other words, the correlations show that sales tend to be lower in those areas where prices are relatively high and that sales tend to be higher in those areas where prices are relatively low. This result is reasonable in the light of economic theory and is consistent with the findings of other researchers cited in Chapter III.

The correlations between per capita personal income and per customer kilowatt hour sales are surprising in that they are all negative. The negative signs of the coefficients indicate that per customer sales tend to be higher in areas where per capita income is lower and that per customer sales tend to be lower in areas where per capita income is relatively high. There is no theoretical justification for this result. At first examination it does not make sense. However, further consideration unearthed three factors which tend to explain this seemingly contradictory finding.

First, there is the fact that federal power projects tend to be concentrated in low income areas. In a study of the relationship between residential electricity sales and the price of electricity, Wilson also found a negative relationship and provided the following explanation [240, p. 12]:

> Since electricity is not an "inferior good," there is no adequate theoretical justification of this statistical result. Rather it is probably attributable to the fact that federal power projects (and associated low wholesale prices) are concentrated in low income areas. The fact that they are totally absent in the high income northeastern industrial belt from St. Louis to Boston is not the result of random selection nor is it systematically or predictably attributable to market conditions. That being the case, no significant conclusions can be arrived at regarding the income elasticity of demand for electricity.

Second, it has been suggested by Fisher and Kaysen that individuals with higher incomes tend to purchase more services outside the home which would ordinarily involve the consumption of additional electric power if these services had been produced in the home [72]. For example, families with higher incomes tend to dine out more often. They, therefore, tend to use less electricity for cooking. Families with higher incomes are less likely to own home freezers and, therefore, use less electricity for freezing foods. Families with higher incomes are also more likely to have laundry done outside the home and, therefore, use less electricity for clothes washing, drying, and ironing. This discussion is not meant to show that per customer kilowatt hour consumption declines over time in response to the general rise in consumer income.[1] This discussion is meant to show that, in a given area at a given point in time, there may be a tendency for high income families to use relatively less electricity than families with lower incomes.

A final explanation for the negative relationship between income and sales relates to the quality of the income data employed in this study. Earlier in this chapter, the procedure followed to derive per capita personal income estimates for the service areas of the firms in the sample was described. This procedure was quite imperfect and may have been a source of considerable measurement error or measurement bias. Unfortunately there is no way to evaluate the degree of measurement error or measurement bias introduced through this vehicle. It must, therefore, be recognized that the negative relationship found between income and sales might be due to errors or biases in the income estimates.

### Per Customer Advertising Expenditures

As noted earlier, advertising expenditures were converted to a per customer basis by dividing a utility's total advertising expenditures by the total number of residential customers served by that utility. Advertising expenditures were converted to a per customer basis to fit the form of the dependent variable (per customer kilowatt hour sales). Per customer advertising expenditures provide a measure of the relative intensity of advertising effort by the various firms in the sample. This point was discussed in greater detail in Chapter III. Average per customer advertising expenditure data for the firms in the six samples are presented in Table N-11.

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[1] The empirical results in Chapter IV indicate that just the opposite takes place.

The data in Table N-11 clearly show that the average straight electric utility spends more per customer on advertising than the average combination utility spends. Brandon reported similar findings in his study of the differences in the behavior of combination and straight electric utilities. Brandon suggests that combination utilities spend less per customer on advertising because they have no gas company to compete with [34, p. 702].

TABLE N-11

AVERAGE PER CUSTOMER ADVERTISING EXPENDITURES
FOR THE FIRMS IN THE SIX SAMPLES
(In Current Dollars)

| Sample | Average Per Customer Advertising Expenditures |
|---|---|
| 1969 SE | 1.67 |
| 1969 C | 1.44 |
| 1967 SE | 1.61 |
| 1967 C | 1.33 |
| 1965 SE | 1.44 |
| 1965 C | 1.24 |

Source: Federal Power Commission [224]

## TABLE N-12

### VARIATION IN PER CUSTOMER ADVERTISING EXPENDITURES BY THE FIRMS IN THE SIX SAMPLES (In Current Dollars)

| Sample | Lowest Advertising Expenditures Per Customer | Highest Advertising Expenditures Per Customer | Standard Deviation of Per Customer Advertising Expenditures |
|---|---|---|---|
| 1969 SE | .36 | 2.39 | .48 |
| 1969 C | .27 | 3.16 | .80 |
| 1967 SE | .29 | 2.70 | .48 |
| 1967 C | .31 | 2.55 | .67 |
| 1965 SE | .19 | 2.24 | .48 |
| 1965 C | .26 | 2.65 | .65 |

Source: Federal Power Commission [222]

Table N-12 provides information on the variation in per customer advertising expenditures between the firms in each of the six samples. These data show that there is considerable variation in per customer advertising expenditures.

In 1969, the highest spending straight electric utility spent seven times more per customer on advertising than the lowest spending straight electric utility. Also in 1969, the highest spending combination utility spent ten times more per customer on advertising than the lowest spending combination utility. There is considerable variation in per customer advertising expenditures between the firms in a given sample. The question is then, do firms with high advertising expenditures per customer tend to have higher sales per customer? To answer this question, simple correlations were computed between per customer kilowatt hour sales and per customer advertising expenditures for the firms in each of the six samples. The results, shown in Table N-13, indicate the existence of a generally positive, but statistically insignificant, relationship between sales and advertising expenditures. In other words, those firms which spend more on advertising tend to have higher per customer sales. The variable, per customer advertising expenditures will be considered further in the following section.

TABLE N-13

SIMPLE CORRELATIONS BETWEEN PER CUSTOMER KILOWATT HOUR SALES AND PER CUSTOMER ADVERTISING EXPENDITURES FOR THE FIRMS IN EACH OF THE SIX SAMPLES

| Sample | Simple Correlations |
|---|---|
| 1969 SE | - .07 |
| 1969 C | .46 |
| 1967 SE | .02 |
| 1967 C | .46 |
| 1965 SE | .02 |
| 1965 C | .51 |

# APPENDIX O

## DEFINITIONS OF STATISTICAL MEASURES EMPLOYED IN THE STUDY

TABLE O-1

STATISTICAL MEASURES EMPLOYED IN THE STUDY

| Symbol | Definition |
|---|---|
| a | Constant term in linear regression analysis. Represents the Y axis intercept of the linear function in the two variable case.[a]<br>In the three variable case it represents the intercept of the regression plane on the Y axis.[b]<br>In any case it equals the value of the linear function when all independent variables are equal to zero.[a] |
| B | Regression coefficients in regression analysis. Represent the slope of the regression line in the two variable case and, therefore, the average amount of change in the dependent variable per unit of change in the independent variable.[b]<br>In the three or more variable case there is a regression coefficient associated with each independent variable. The regression coefficient associated with each independent variable in multiple regression indicates the average change in the dependent variable per unit of change in the particular independent variable.[b] |
| R | Pearsonian or product moment coefficient of correlation.[c] Measure of association between the dependent variable and independent variable or variables.<br>In the two variable case R provides a measure of how well the calculated regression line fits the actual data.[d] In the more than two variable case R measures how well multidimensional regression plane fits the actual data.[d] |

TABLE O-1 Continued

| | |
|---|---|
| | R can vary from +1 to -1. An R approaching +1 indicates a strong positive association between the dependent and independent variables. When R approaches -1 a strong negative or inverse relationship is indicated. Finally, if R is near zero one can conclude that no relationship exists between the dependent and independent variables. |
| $R^2$ | A second measure of association between the dependent and independent variables. Referred to as the coefficient of determination. It is equal to the Pearsonian or product moment coefficient of correlation squared.[a]<br>Very simply the coefficient of determination is the ratio of the explained variation to the total variation. Total variation equals the sum of the actual Y values minus the mean Y value squared. Explained variation equals the sum of the computed Y values minus the mean Y value squared.[a]<br>The $R^2$ value tells the analyst what percent of the total variation in the dependent variable is explained by the independent variables.[a] For example an $R^2$ of .90 indicates that the independent variables explain 90 percent of the variation in the dependent variable.<br>Since $R^2$ is equal to the correlation coefficient squared it may assume a value of from zero to one. The closer to zero the less the degree of association. The closer to one the stronger the degree of association. |
| u | The stochastic disturbance or error term--unknown random error.[b] It is the residual or unexplained variance in the dependent variable. It is sometimes referred to as the residual variance or simply the residual.[e]<br>Johnson notes three sources of this residual error.[b]<br>1. The investigator could explain all the variation in the dependent variable if he knew all the causative forces at work and could obtain precise data on each. Since this is never possible there is always some unexplained variation.<br>2. A second reason for presence of the error term in economic relations is to assume that, beyond the total effect of all relevant factors there is a basic and unpredictable element of randomness in human responses which can be adequately characterized only by the inclusion of a random variable term.[b]<br>3. A third source of this random error lies in "errors of observation or measurement. It may be that a variable Z is exactly related in a linear fashion to X by the relation |

TABLE 0-1 Continued

| | |
|---|---|
| | $Z = z + BX$, but errors of measurement obscure the true value $Z$, and instead of $Z$ we observe $Y = Z + u$ where $u$ denotes the measurement error. |
| t | Student's t. A standardized variable used to test the hypothesis that $B = 0$ (there is no relationship between the dependent variable and a particular independent variable) throughout the dissertation.[a] |
| F | Statistic calculated by dividing the explained variance by the unexplained variance. Used to test the hypothesis that $R^2 = 0$ (there is no relationship between the dependent variable and one or more independent variables) throughout the dissertation.[a] |
| d | Durbin-Watson statistic. Test used to detect the presence of autocorrelation in a particular regression model.[a] |

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[a] Taken from Theil [202]

[b] Taken from Johnston [102]

[c] Taken from Shao [178]

[d] Taken from Green and Tull [84]

[e] Taken from Wentz [235]

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Roger Howard Gates was born on March 30, 1942, in Dayton, Ohio. He graduated from Central Catholic High School in Fort Lauderdale in 1960 and entered the University of Florida in 1962. Mr. Gates earned the Bachelor of Science in Business Administration with honors from the University of Florida in 1966 and the Master of Business Administration from the same university in 1967. He enrolled in the Ph. D. program, majoring in marketing, at the University of Florida in the fall of 1967. He was a graduate assistant in the Bureau of Economic and Business Research, an NDEA IV fellow, and an instructor in the Department of Marketing at various times during his graduate program. In 1970 he accepted a position as Assistant Professor of Marketing at the University of Texas at Arlington. He holds this position at the present time. Mr. Gates has also done considerable work as a marketing consultant in the North Texas region. He is a member of the American Marketing Association, Southern Marketing Association, Southwest Social Science Association, and American Institute for the Decision Sciences.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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Professor of Marketing

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This dissertation was submitted to the Department of Marketing in the College of Business Administration and to the Graduate Council, and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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